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Better Grading Makes Stronger Tile That Cost Less

By HARVEY WHIPPLE

There are several things about the plant of the Acme Concrete Products and Gravel Co., Cement City, Michigan, which make it unusual and its operations interesting. The things which make the plant unusual do not isolate it among products plants; its operations are such that other manufacturers, producing under entirely different conditions, with respect to source of materials and market for products, may draw valuable lessons from the way the problems of the Acme plant have been solved.

Cement City is the site of the plant of the Peninsular Portland Cement Co., although the two companies are entirely independent. The cement plant has been operating for 20 years; the gravel plant was set up in 1924; the products plant was ready to begin operations January 1, 1925.

The Market

The products plant faced these governing conditions: Cement and a practically inexhaustible supply of good aggregate were at its door.

Cement City would afford a negligible market; practically 100 per cent of the plant's output must be shipped. Jackson, a city of 50,000, 13 miles away, was the nearest market of consequence. Detroit, 90 miles distant, and Toledo offered market possibilities.

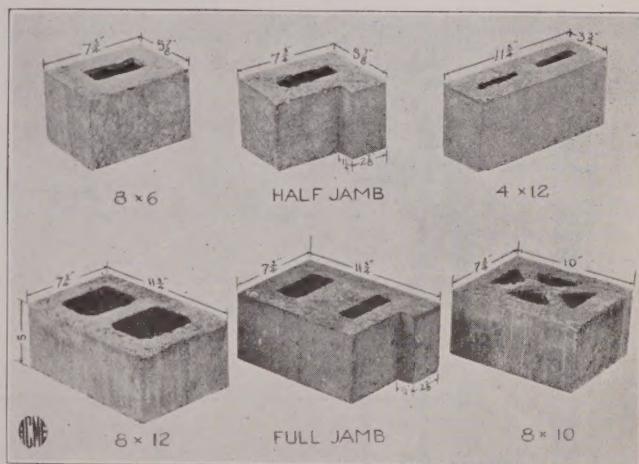
A large stock of building units could be carried without tying up very much cash capital in raw materials.

Freight charges dictated a light-weight unit. Entering a foreign market against local competition imposed the necessity of a product with especially good selling points. It must be of unquestionable quality. Yet to make any money at the business required quantity production on the most economical basis which could be arrived at. We should see whether scientific proportioning and operations in general meant the same thing as economical proportioning and operations.

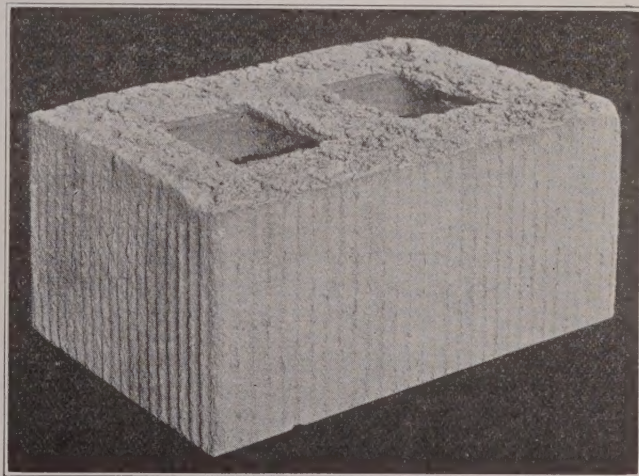
The Organization

Managing the business, solving these problems and making the decisions was E. W. Dienhart. Mr. Dienhart is chairman of the American Concrete Institute's Committee P-1, Standard Concrete Building Units. He played an important part in writing what are now the Institute's standard specifications for concrete building units. His professional connection as an engineer has been with the Cement Products Bureau of the Portland Cement Association, where the major consideration in his work was to sell to products manufacturers the idea of applying scientific knowledge to operations which in all too many cases

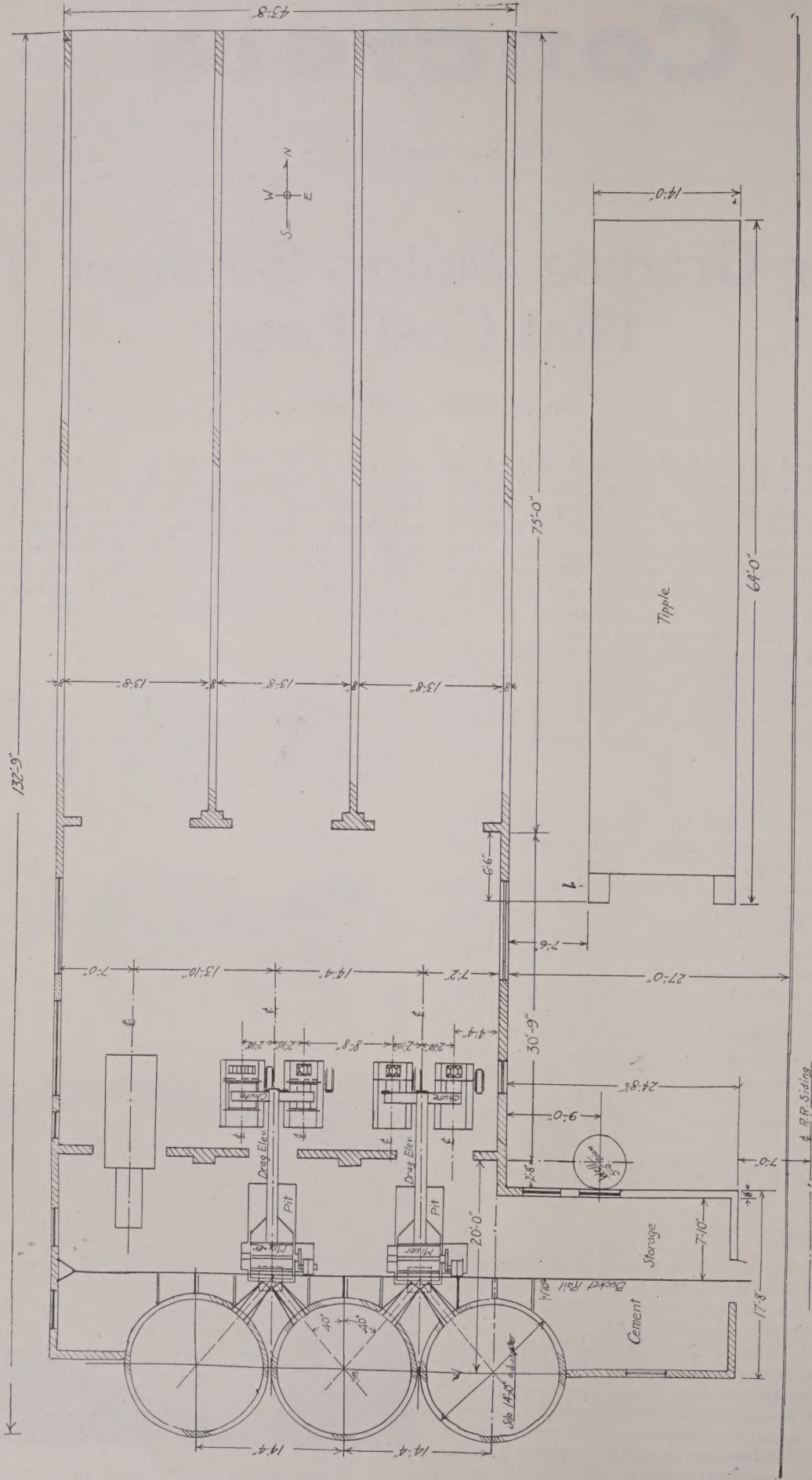
were arbitrary or entirely haphazard. In the Acme plant, due to the conditions of operation which have already been mentioned, he would have an opportunity, which he was bound to be rather enthusiastic about, to test the scientific methods in which he believed so thoroughly. Perhaps the most interesting thing about the present Acme plant is the simplicity of the solution of these scientific problems as they applied to the particular conditions in hand.



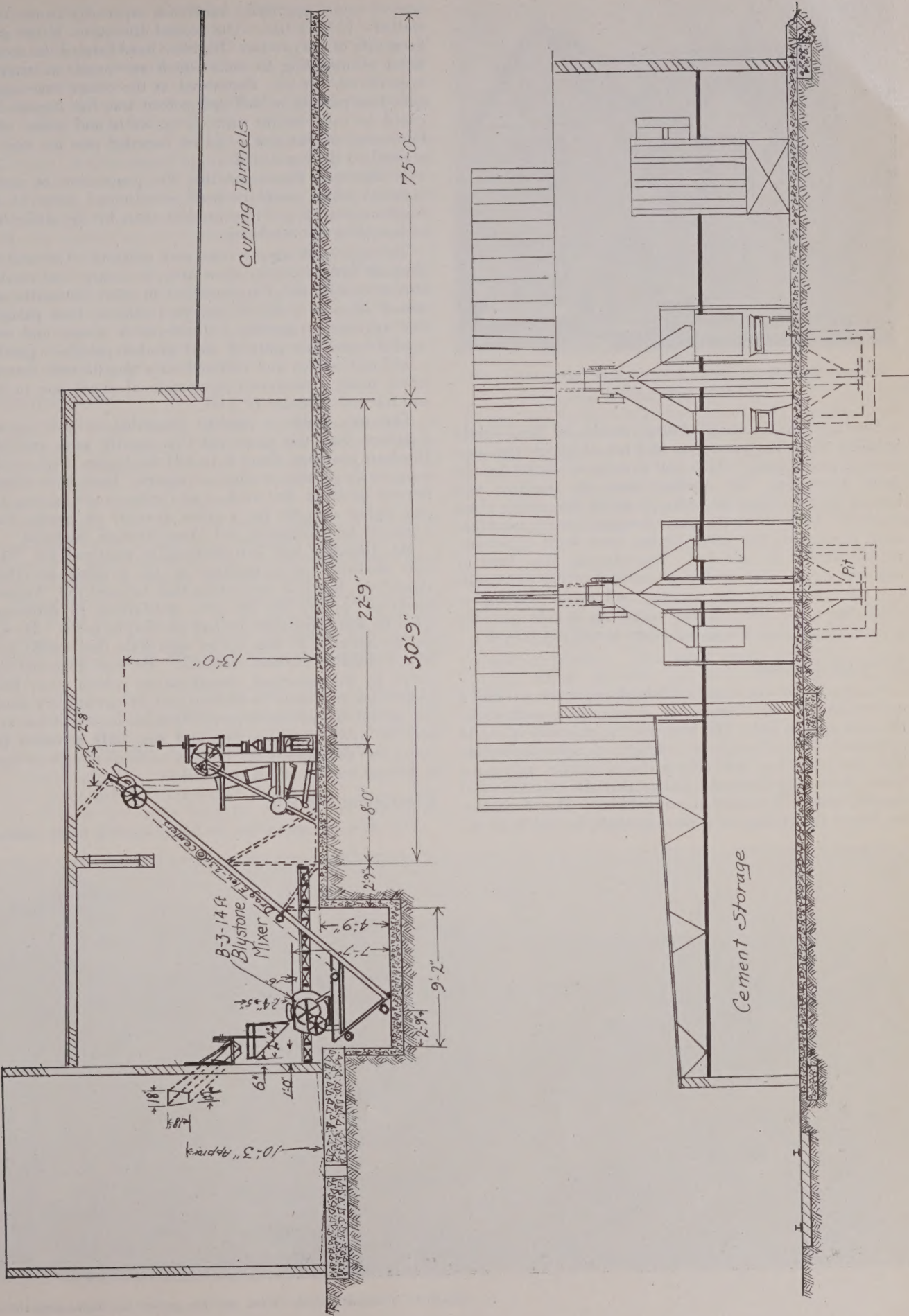
Here are the products of the Acme plant

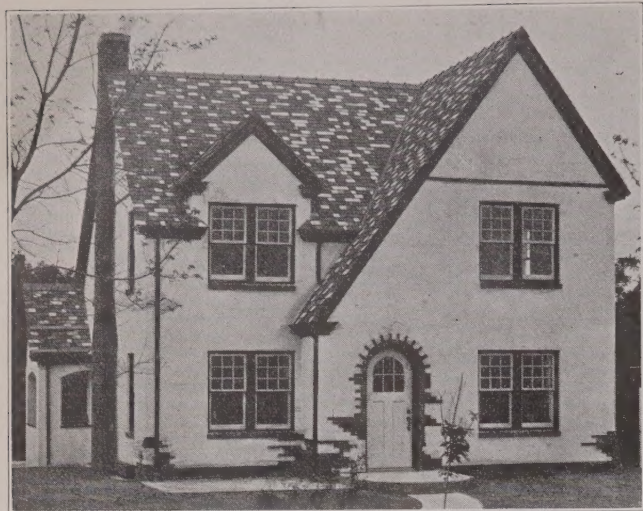


Standard Acme 5x8x12 tile as it is now made



Plan of plant, showing the location of all the principal equipment and the dimensions of the plant structure





Jackson, Michigan, residence built of Acme tile covered with portland cement stucco

The unit to be manufactured would be light-weight building tile. The plant was laid out alongside the commercial gravel plant which had first been erected by the Acme Company. An Anchor hand tile machine was bought first to make the units of which the entire plant is built. Then three Anchor automatic power machines were purchased—the plant having been built to accommodate double this number. Two circular bins, built of concrete staves, were erected at one end of the plant, one for sand, the other for pebbles, and ample space provided for stock piles of both materials to tide over the winter season when the gravel plant would not operate.

Scientific Grading

Structural tile are usually made of aggregate passing a quarter-inch screen, frequently of aggregate well under the quarter-inch size. The first rule for economy is coarse aggregate. The first rule for strength is coarse aggregate. The first rule for low absorption is coarse aggregate. These three considerations dictate that the concrete used should contain a maximum of pebbles. The limitation on this is the operation of the machines, in which an ex-

cess of coarse aggregate interferes, especially in the thin-walled ($\frac{7}{8}$ in.) tile. The second limitation is the marketability of the product. Builders have formed the mental habit of objecting to units which are rough in external appearance. It was discovered at the outset that aggregate just passing a half-inch screen was the largest that could be used in tile with $\frac{7}{8}$ in. walls and webs. Just how much of this size could be crowded into the mix remained to be discovered.

It was next discovered that the proportion of coarse material which could be used was limited more by the rough appearance of the product than by the difficulties in operating the machines.

The aggregate supply runs very uniform. Cut and try methods with strength, absorption, economy, and marketability (roughness of appearance) in mind eventually simmered down to a mix of one part cement, four parts of fine aggregate (passing a quarter-inch screen and well graded) and one part of well graded pebbles (passing a half-inch screen and retained on a quarter-inch screen) which made a combined proportion of about one to five and fineness modulus of 4.00.

This mix makes a product somewhat rougher in appearance than the structural tile usually seen and Mr. Dienhart has gone about it to sell the bigger users on the superiority of the product so made. Tests have shown beyond question that such a mix gives lower absorption and higher strength for a given quantity of cement than a mix of finer material and lower fineness modulus.

Mr. Dienhart had first thoroughly mastered the "fineness modulus" as a measure of his grading as others should do, but it is interesting that he used the "fineness modulus" purely for his own satisfaction to determine *what* he was using *after* he had decided to use it. He did not go about it to mix up an aggregate that would give him a definite fineness modulus. He was governed entirely by the practical considerations which have been mentioned and when he had arrived by cut and try methods at the mix of maximum coarseness he could use and sell the product of, he then and then only screened the result and determined the fineness modulus merely to have a definite record of his material.

Controlling the Mix

This does not mean that he has discarded those control



Exterior panorama of the plant and the gravel pit, indicating the relative positions

methods which he has advocated. Sieve analyses are made practically every day and serve as a valuable check on the mix so laboriously decided on so that a change of proportions can be made intelligently. The fineness modulus, as a measure of the coarseness of the mix, serves as a constant indicator in keeping that degree of mix coarseness which has so many things in its favor.

Nor has the mix now being used been decided on for all time. An increased appreciation among builders of units made with as much coarse material as possible may at any time result in a change to more coarse material with its higher fineness modulus, giving the same strength with less cement or more strength with the same cement, and lower absorption and greater economy of production up to the limit of the machines to avoid jamming under an excess of coarse particles. If Mr. Dienhart were making the heavier walled concrete block he would, he says, use material up to that size just passing a one-inch screen, giving much greater economy per pound of concrete produced than with the thinner units.

Strength Tests

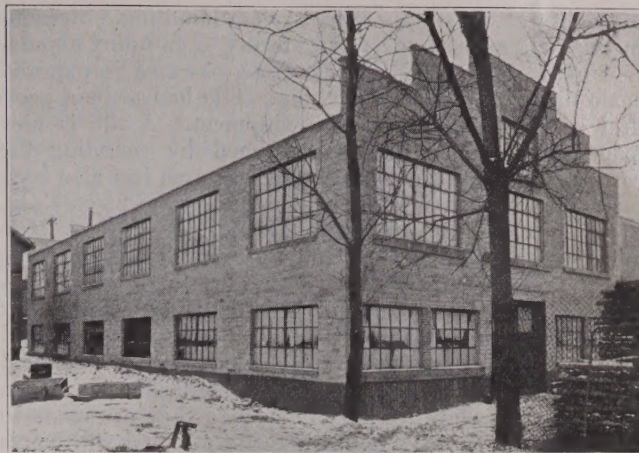
Here are some results of tests of products made the latter part of November, 1925, using four different mixes. The units were cured 24 hours inside at a temperature of about 70 degrees, 28 days outside (cold weather) and 14 days inside at about 50 degrees.

Specification No. 2: Two sacks cement, 11 cu. ft. of sand and 5 cu. ft. of pebbles—combined proportion 1 to 7. Average of three tile tested 1130 lb. per square inch gross area (5.5 bbls. of cement per 1000 tile).

Specification No. 2½: Two and one-half sacks cement, 11 cu. ft. of sand and 5 cu. ft. of pebbles—combined proportion 1 to 6. Average of three tile tested, 1340 lbs. per square inch of gross area (6.6 bbls. of cement per 1000 tile).

Specification No. 3: Three sacks cement, 11 cu. ft. sand and 5 cu. ft. of pebbles—combined proportion 1 to 5. Average of three tile tested 1643 lb. per square inch of gross area (7.8 bbls. of cement per 1,000 tile).

Specification X: Two sacks cement, 9 cu. ft. sand and 7 cu. ft. of pebbles—combined proportion 1 to 7. Average of three tile tested 1310 lb. (5.5 bbl. of cement per 1000 tile).



The Acme Company likes to sell to industrial jobs. They run into quantity, and the owners have a better appreciation of quality

It is interesting to note that while the mix No. 2½ with 25 per cent more cement than No. X uses 5 parts of pebbles to 11 parts of sand, it gave practically the same strength as "X," in which there are 7 parts of coarse aggregate with 9 parts of fine. It is also interesting and economically important that mix "X" gave nearly 16 per cent more strength than mix No. 2 with the same quantity of cement, by reason of the greater proportion of coarse particles.

Designing the Units

Another interesting problem of the plant was in determining the precise design of the tile to be manufactured. It was necessary to get the most strength into the least weight of product. The work began with the standard 5x8x12 Hi-test tile with diagonal webs weighing 22 lbs. With the idea of providing more load bearing strength in less weight tile were made with two rectangular cores having sharp square corners, the walls and webs spread at the top for more mortar area, so that the opening for hand-hold in each core was 3½x4½ in. This tile weighed less than 16 lbs. and proved to be too light in design, even with a concrete giving a high compressive strength. It was not too light to meet structural requirements but



Every element of the works and demonstrating the essential simplicity of the layout

too light to stand shipping and rough handling. Strength in the wall to meet the requirements of building regulations where only 700 lbs. over the gross area is required came to mean absolutely nothing. Tile had to be a good deal better than that to stand shipment. A tile is now made weighing 18 lbs., strengthened by rounding the corners of the core areas. The mortar area has also been increased so that the two openings on top are $2\frac{1}{2} \times 3\frac{3}{8}$ in. Breakage has been reduced to practically nothing. It is months since the plant has had any complaint of breakage and a guarantee of no breakage is given with every shipment. Increased strength of the tile is responsible for part of this and method of loading has had a good deal to do with the more satisfactory results. Tile are piled so that the impact of bumped and shunted cars is taken by the tile in the direction of the load they are made to take in the structure; that is, the tile are laid with cores horizontal and the car packed full, end to end.

A special tile has to be made for the Detroit market which is accustomed to an odd-size brick, $2\frac{5}{8}$ in. thick. Tile are made $5\frac{1}{2}$ in. high to lay up to two brick with the usual mortar separation.

It is an interesting fact in connection with the development of a lighter tile to do the work of a heavier one that by using exactly the same quantity of cement per thousand 18-lb. tile as per thousand 22-lb. tile, tests showed the same strength over the gross area of the two units, at the same cost for cement, a slightly less cost for aggregate and with a saving of two tons less shipping weight per thousand units.

The Plant Arrangement

The accompanying drawings show the layout of the plant in most details. A belt conveyor alongside the bins of the commercial gravel plant takes sand from one of the gates and in about half an hour fills the circular sand bin of the products plant. This sand gate is closed and the pebble bin gate opened and the same belt, with a swinging chute at the end, fills the pebble bin. In the open season when the gravel plant is in operation, a surplus of sand is sluiced to a stock pile; similarly a stock pile of pebbles is built up for winter operation. A horse and scraper drag these materials in winter to the boot of a bucket elevator which keeps the two plant bins filled.

These two bins feed through chutes into a single measuring chute which feeds directly into a 14-cu. ft. oversize Blystone mixer. The measuring chute, lying on an angle of about 45 degrees, has a slide gate at the bottom just above the mixer. The chute is boarded up on the top side to a measuring point. It is twice filled to this point with sand and once with pebbles for each batch. The water is added according to the judgment of the mixer man, since the water content of the aggregates varies a good deal. He keeps the mix as wet as the machine operators can handle it.

Steam Coils for Winter

In both aggregate bins are perforated steam coils, just below the level of the chutes and at approximately the same angle, so that the material for each batch, under winter operation, comes out hot. Water is used warm with 2 lbs. of calcium chloride per sack of cement, these precautions of heat being employed, of course, only for cold weather operations.

The concrete is mixed three full minutes. In winter operation, with only one of the automatic tile machines in use, the mixer capacity greatly exceeds the requirements and a batch is frequently mixed as long as ten minutes, which is of advantage in reducing any frozen lumps of aggregate which slide too rapidly over the steam pipes.

The mixer dumps into the boot of a drag elevator which lifts the concrete to a small hopper. This in turn feeds to a belt conveyor which operates in either direction in the line of tile machines to feed the machine hoppers.

Production per machine with two men per ten-hour day is about 3000. Tile are stacked on racks and carried to curing rooms with lift trucks (Cowan and Jack Lift). Curing rooms are heated by steam in working hours and when a room is filled by opening a valve, the steam at 20 lbs. pressure passes into perforated pipes and is admitted directly into the room. Steam room capacity is just about equal to full production so that the yard men clear one aisle the first thing the following morning so that the fresh product may go in while the tile of the day before are taken to the yard.

The yard has wide paved aisles for lift truck operation and Standard gravity carriers are employed in carrying the tile back for stock piling. By operating the carriers in two lifts tile are piled ten feet high. Stacks of tile are dated as they are built up, so that the age of tile at shipment is always known.

Production Charts

Over Mr. Dienhart's desk is an operating chart, which he has watched with a good deal of interest to see the kinks come out of the lines traced there. There are two lines—one for daily production, the other for cost of production per thousand tile. In 1925, when a good deal of experimental work was done and a good many changes made and many "bugs" taken out of operation, 750,000 tile were made. At no time were all three machines in operation and for but four months were two machines in use. The production line in the chart has been getting more and more consistent since the middle of last August, when a change was made in the basis of pay to the crews. Similarly, since that time the cost line on the chart dropped several steps until full winter operating conditions were encountered in December when there was a slight step upward.

This production cost (labor only) was beaten down in 1925 from \$13 per thousand tile to \$8. Most of the reduction came along with the more consistent quantity production which started with changing the wage scale of the crews from 35 cents to 40 cents an hour with a bonus, bringing the wage to 45 cents for every day a machine produces 3000 tile.

Records kept on materials used per thousand tile show a consistent cement content. The average is 7.9 bbl. and the daily variation is in very small fractions.

The company is fortunately situated with respect to raw materials and with solid faith in the ultimate sale of its output. This has governed in the policy to produce 3,000,000 tile in 1926. It is believed that such a policy will be a big help to selling, in keeping down the production and overhead cost.

The easiest way to sell concrete block is to sell concrete houses. While you are about it, don't forget to sell a concrete floor and a concrete roof, even though you are not a dealer in aggregates, cement, or roofing tile. The all-concrete house is the easiest thing on earth to sell, and the prospective owner is your easiest prospect.

The water-cement ratio system of job control is not limited to the large job. The idea has been worked out for the smallest concreting operation, and instruction cards have been worked up that enable the foreman to control the quality of the mix with a minimum of effort. It takes but a moment to determine the right proportions and start the mixer working. It is so simple that any intelligent man can understand it and use it to advantage.

Water-Ratio Specification a Success

By the Use of a Strength Specification by Water-Cement Ratio the Contractor on the Portland Cement Association's New Home Was Able to Give the Owners Better Concrete with a Saving of Cement and an Almost Complete Elimination of Patching—No Need for Extra Technical Supervision

The quality of the concrete in the office and laboratory building of the Portland Cement Association was successfully controlled, without the use of special equipment and without the need of a testing organization, solely by means of a specification based upon the control of the water. This specification fixed only the proportion of water to cement. The aggregate proportions were left entirely to the judgment of the contractor, with the limitation that plastic and workable mixes be produced. Other than standard paragraphs dealing with quality of materials, etc., the entire matter of proportioning and strength appeared in the specifications in the following simple paragraphs. Detailed but concise explanations of procedure accompanied the specifications in the form of suggestions to bidders. The specifications read in part:

Water-Cement Ratio

"Concrete for structural members shall be proportioned to give the necessary workability without exceeding the following ratios of water to cement:

	Water per sack (94 lb.) of cement
"Where concrete of strength of 2900 lb. per sq. in. is called for	6.0 U. S. gal.
"Where concrete of strength of 2000 lb. per sq. in. is called for	7.5 U. S. gal.

"These water-cement ratios are the maximum permissible. The mixes shall be proportioned for somewhat lower ratios so that, with the normal fluctuations which may be expected from batch to batch, these ratios will not be exceeded. Water or moisture contained in the aggregate must be included in computing the water-cement ratios. Water absorbed by the aggregate in a period of 30 minutes may be deducted in computing the water-cement ratio.

"The water-cement ratios specified shall not be changed except by the Architect. In the event that the Architect finds it necessary to change the water-cement ratios from those specified, adjustment, covering amount of cement and aggregates affected, will be made as an extra or a credit under the provisions of the contract.

Concrete Proportions and Consistency

"The proportions of aggregate to cement for concrete of the water-cement ratios specified shall be such as to produce concrete that can be puddled readily into the corners and angles of the form and around the reinforcement without excessive spading and without undue accumulation of water or laitence on the surface. In no case shall concrete be placed which shows a slump exceeding the following limits:

"For caissons	Max. Slump 4 in.
"For heavy walls, slabs and beams	Max. Slump 7 in.
"For thin walls and columns	Max. Slump 9 in.

"The proportion of fine and coarse aggregates shall be such that the ratio of the coarse to the fine shall not be less than 1 nor more than 2, nor shall the amount of coarse material be such as to produce harshness in placing or honeycombing in the structure. When forms are removed, the surface and corners of the members shall be smooth and sound throughout."

This form of specification was first prepared by F. R. McMillan who thought it feasible to control the quality of

Abstracted by permission from a paper read by F. R. McMillan and Stanton Walker at the 22nd Annual Convention of the American Concrete Institute, and appearing in the copyrighted Proceedings of the Institute.

concrete solely on the basis of the water-ratio and workability. He proposed leaving questions of economy, as affected by the consistency, proportions, and size and grading of the aggregates, to the contractor, in the same way as are questions of plant layout procedure. This was first proposed for use on the construction of the Memorial Stadium of the University of Minnesota. Since then it has been successfully tried out on large and small work by a number of engineers and has proven to be a meritorious type of specification.

On the construction of the Portland Cement Association building, which was designed and supervised by Holabird and Roche, architects, Chicago, and constructed by the Turner Construction Company, the specification was given a real test and still further proved its worth. It produced concrete stronger than called for, and yet made it possible for the contractor to save money on the work.

Strength Watched by Laboratory

The operation of the specification was closely observed and a regular program of tests were carried out by the Structural Materials Research Laboratory. The compressive strength of the concrete was determined at 3, 7, and 28 days in 6x12-in. cylinders taken each day from several batches immediately before they were deposited in the forms. Frequent determinations of sieve analyses and of moisture content of the aggregates were made throughout the work. In general the tests were made in accordance with the standard methods of the American Society for

Testing Materials.

As may be seen in the specifications quoted there were two classes of concrete specified, one to attain a 28-day strength of 2900 lb. per sq. in. and another that would be at least as strong as 2000 lb. The water-cement ratios governing these strengths, as listed in the specifications, were only the maximum permissible. Operating tolerance to cover variations in proportioning was required to be entirely on the lower side, so the actual ratios used were somewhat richer than actually required. It was found to be to the contractor's advantage to keep the fluctuations at the lowest possible limit permitted by the equipment available, for by so doing he was able to secure the specified strengths with a minimum amount of cement per yard of concrete. Under this arrangement the contractor was permitted to use the simplest possible plant, but a greater uniformity in strength might have been possible had more accurate measuring devices been used.

The complete results of the strength tests are given in tables 4 and 5. Summaries in tables 2 and 3 show averages for certain groups of tests, arranged in order of the mean temperatures prevailing on the days that the concrete was placed. Figure 1 shows the strengths plotted for the different water-ratios, together with the curve representing the water-ratio-strength law upon which the specifications were based.

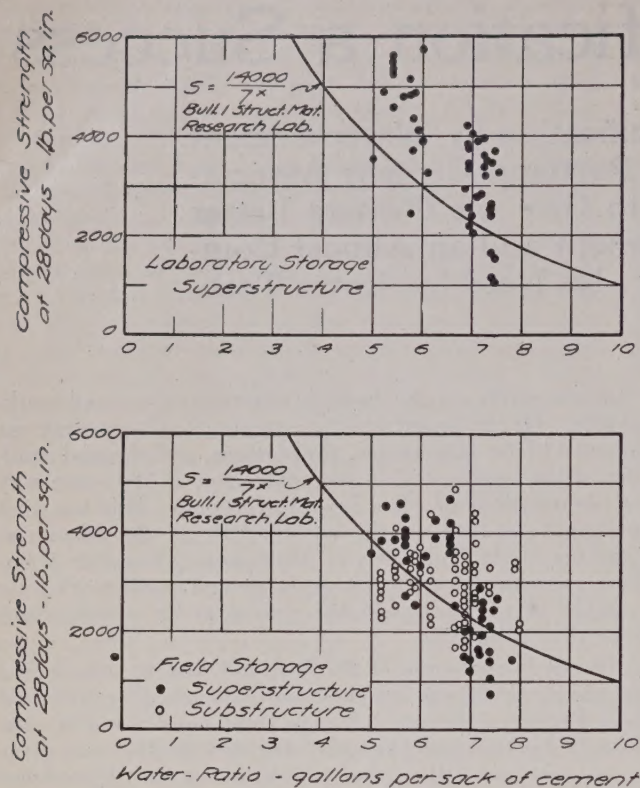


Fig. 1. Compressive strength of concrete at 28 days, of 6x12-inch cylinders cured in the field and laboratory. Each value represents a single specimen

No Disputes

As the specifications on strength and on workability worked out there was no occasion for argument over the consistency or proportions. In placing the concrete in the caissons the tendency was all towards the use of consistencies approaching the limit of stiffness. On the superstructure the tendency was toward the other extreme. The old argument as to the amount of the mixing water was entirely lacking. When it seemed to be desirable to have a more fluid mix, it was obtained by reducing the aggregate proportions, leaving the water and cement quantities in the batch unchanged. The conflicting desire on the part of the contractor always to have plastic workable mixes and yet to keep the cement factor low by the use of the largest possible amount of aggregates, resulted in mixes entirely within the range specified and very suitable for the work.

The average mixes and the resultant slumps for the different classes of concrete and portions of the structure were as follows:

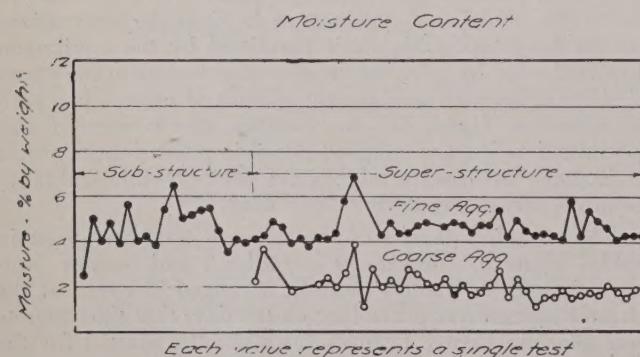


Fig. 2. Moisture content of aggregates delivered at the job. Each value represents a single test. There was really no great variation in moisture content

Class of Concrete	Average	Mix	Average
28-day Strength lb. per sq. in.	Damp and Loose	Dry Compact	Slump in.
SUBSTRUCTURE			
2000	1-3.0-5.4	1-2.5-4.5	1 1/2
2900	1-2.4-3.5	1-2.0-3.25	1 1/4
SUPERSTRUCTURE			
2000	1-3.0-3.9	1-2.5-3.6	7
2900	1-2.0-3.0	1-1.7-2.7	6

The contractor was required to measure the materials in such a way that the water-cement ratio could be closely controlled during the progress of, the work and easily checked at any time. To simplify control aggregates had to be purchased from such a source as to insure uniform grading and quality during each day's operation. Aggregates were delivered by truck and stored on the street in small quantities. Good delivery service made small stock piles possible. The aggregates were measured in wheelbarrows on the caisson work and in buggies on the superstructure construction. Frequent moisture determinations were made on the site to allow necessary corrections to be applied at the water tank whenever found to be advisable.

Measuring the Materials

In the caisson work the water was measured in a closed tank directly connected to the city water supply and equipped with a check valve which closed when the tank was filled. The tank was filled and discharged through a three-way valve, the quantity discharged being regulated by means of a movable pipe. Owing to the inherent deficiencies of this style of tank this device was not particularly satisfactory and it was necessary to make considerable allowance to insure that the specified water ratios were not exceeded. The unreliability of this water measuring device, combined with wheelbarrow measurement of aggregates, resulted in a considerable lack of uniformity in the strengths, as will be noted in the lower diagram of Fig. 1.

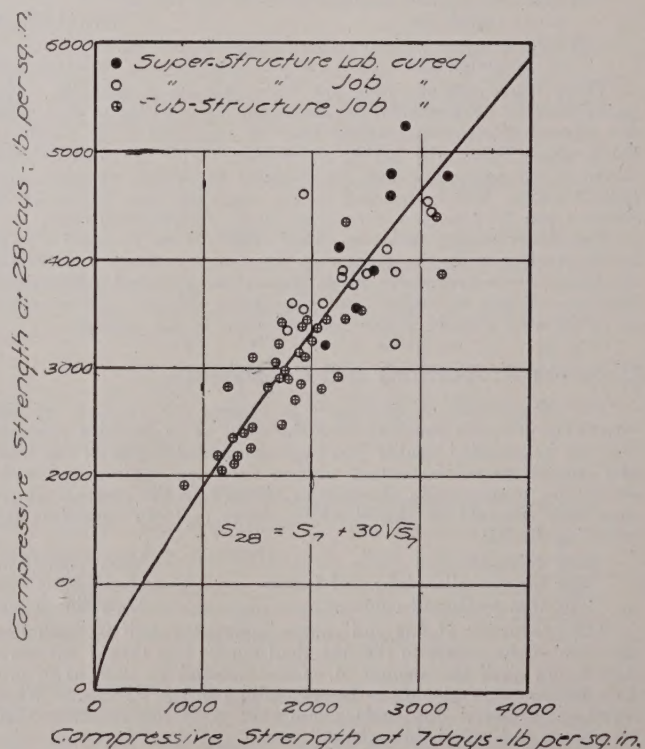


Fig. 3. Comparison of 7- and 28-day strengths of specimens taken from the same batch. In about 50 per cent of the cases two specimens were made for the 28-day test. The plotted values for these cases are the average of the two tests. These relationships seem to indicate the feasibility of using the 7-day test as a true measure of the 28-day strength of concrete, by means of the equation shown

On the superstructure, the water-measuring device consisted of a calibrated open tank provided with an adjustable overflow pipe which prevented more water being let into the tank than was required for the batch. This device permitted quite accurate measurements of the water, but corresponding accuracy was not gained in measuring the aggregates, which were measured in buggies in fractional quantities. This condition led to some variation in strength.

As a result of studies of the moisture content of the aggregates, determined by weighing and drying, and by means of an experimental apparatus for measurement by displacement, it was found that the moisture content did not vary sufficiently to seriously affect the actual working of the water-cement ratio. It is not thought that variations in water content would prove embarrassing on the average job.

Cement Was Saved

The caisson contractor on the job, the Mid-Continent Construction Company, reported a cement factor of 1.17 bbls. per cubic yard for concrete showing an average strength of 2880 lb. per sq. in. at 28 days. This was reported to be about one sack per cubic yard less than was usually used on that class of work. This saving was effected through the use of consistencies much stiffer than is the usual practice and comparatively large aggregate. The aggregate was graded up to 1½ in. The consistency was, however, at no time too stiff for proper placement. Each caisson shaft 70 to 75 ft. in depth, was placed continuously in three to four hours with no water appearing on the surface, although the surface was at all times plastic. During the half hour's time needed for placing the dowels at the top, a man standing in the concrete would gradually sink to a depth of 6 to 10 in., and small quantities of water would show in spots.

In the superstructure the average cement factor for the entire structural work including both classes of concrete was 1.47 bbl. per cu. yd. Of the total yardage, about 40 per cent was of the 6-gallon water-ratio class and 60 per cent was of the 7½ gallon water-ratio class. The cement factor for 417 cu. yd. of concrete of the second class was 1.31 bbl. per cu. yd. This factor, as well as the average for the job, is slightly more favorable than is the usual practice for a similar type of structure.

Some engineers have expressed concern that conflicting

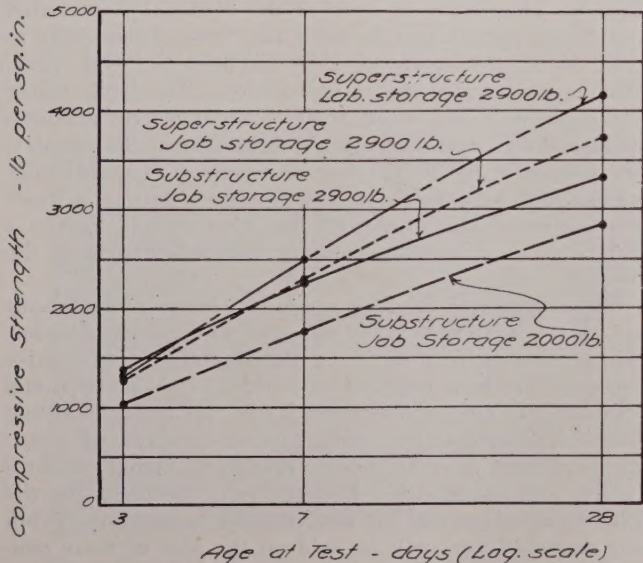


Fig. 4. A comparison of the 3-, 7-, and 28-day strengths. Specimens were all taken from the same batch for each group, and the plotted values are the averages of all specimens for the group considered

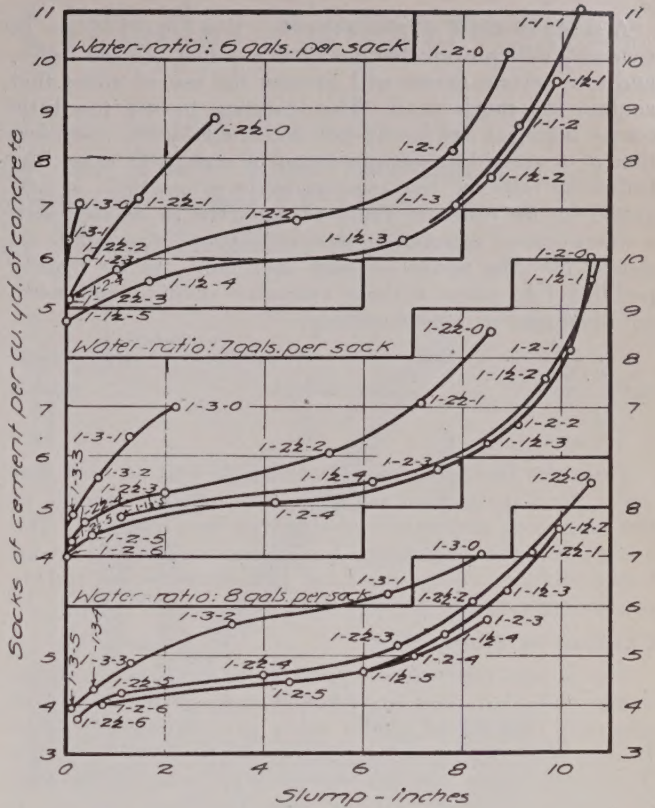


Fig. 5. The relation between quantity of cement and consistency. These curves are a useful guide on the job. They were based upon Elgin sand, 0-4, with a fineness modulus of 3.14, and upon Elgin pebbles, 4-1½, with a fineness modulus of 7.00. Other aggregates would alter the numerical quantities shown, and each set of aggregates from any given source would have their own set of curves, as explained in the paper

desires concerning cement factor and cost of placing may not always be depended upon to give proper workability, and that unsatisfactory work, or at least a cause for argument, may result. In this connection some relationships between water-cement ratio, cement factor, and consistency, which have been brought out by studies at the Structural Materials Research Laboratory may be of interest. Fig. 5 represents such relationships for sand and gravel aggregates with varying water-ratios and mixes. Each diagram consists of curves showing the relation between the sacks of cement required per cubic yard of concrete and the slump for the given water-ratio. Each curve contains the results for a family of mixes. These curves are only true for this particular set of aggregates, but other aggregates will give similar curves with different numerical relationships. The curves show a saving of less than half a sack of cement in a reduction of slump from 6 to 2 inches, but when the slumps are increased above 6 inches the extra cement required increases rapidly. For instance, as much as 2½ sacks of cement per cubic yard may be saved by reducing the slump from 9 to 6 inches.

Another point of interest and importance is illustrated by the curves in Fig. 5. Take the mixes that will give a 6-inch slump with a water-ratio of 7 gal. of water per sack of cement, for instance. These are 1-1.5-4.0, 1-2.0-3.5, and 1-2.5-1.7, requiring respectively 5.2, 5.4, and 6.4 sacks of cement per cubic yard of concrete. For the usual range in prices the 1-2.0-3.5 mix will be found the lowest in cost for materials, and it will be the cheaper to place because of the greater sand content. The 1-2.5-1.7 might be the lowest in cost to place, but the total cost margin would be slight, if any, because of the excess of fine material. This is an undesirable mix and would not be permitted under this specification.

A study of these curves will show that consideration of economy will prevent the use of mixes that are too harsh, and to a certain extent will prevent the use of mixes that contain too much sand. The tendency to use too little coarse material can easily be controlled by the specification of a suitable minimum ratio of coarse to fine. The following table of limiting aggregate proportions is suggested for the ordinary range of materials to be used with a water-cement ratio strength specification, where it is required that the mixes be such that they can be readily puddled into place without excessive spading and without harshness or honeycombing.

Size of Coarse Aggregate, Inches	Ratio of Coarse to Fine on Basis of Dry Compact Volumes	
	Minimum	Maximum
$\frac{3}{8}$	0.4	0.8
$\frac{1}{2}$	0.6	1.5
1 and over	1.0	2.0

From the foregoing considerations it will be seen that under the water-cement ratio specification the interests of the contractor and owner are more or less identical. The mixes that the contractor finds economical will avoid honeycombing on the one hand and excess water and its consequent porosity on the other.

Checked by Slump Test

The slump test was not used as a governing test for workability, but only to reveal changes in the nature of materials that would render other proportions advisable. It will show unsuspected changes in proportioning and in water content, as the test is very sensitive to such changes. It will not tell just what has happened, but it will indicate that something has arisen at the mixer that will require immediate investigation and correction.

In estimating the probable amount of aggregates and cement to be needed under such a specification no particular difficulty need be feared. After a little experience with this type of control the contractor can easily use the usual tables of quantities and determine the quantities of materials to be required. A few trial batches may be advisable in case of doubt, especially where a new source of materials is to be encountered. With the water-cement ratio fixed, the most important factor affecting the quality of the concrete is the consistency or fluidity of the mix. The contractor must determine for himself what mix he will find necessary with the given materials to produce the consistency which he will require.

Water and Cement Prime Factors

The essence of the water-cement ratio specification consists only in the establishment of definite water-ratios with the single qualification that aggregates be used in such quantities and combination as will give workable mixes. The water-ratio-strength relation used in the specification is that appearing in "Design of Concrete Mixtures" by Duff A. Abrams. When mixes which are plastic and workable are used with these water-ratios, the strengths indicated should be obtained with a fair degree of accuracy. Likewise, as found on the work covered by the paper, the quantities of cement shown for the different mixes, are quite accurate for materials of the same character and assumed conditions as those used as a basis for the tables. Bulking of 25 per cent for the sand and 8 per cent for the gravel as due to moisture content and method of measurement were assumed. For different grading of aggregates and for different degrees of bulking the cement quantities will not be the same.

Experts Not Needed

The experience on this job demonstrated convincingly that no necessity existed for an experienced testing organization to control the proportions. This does not mean that the usual and necessary tests of quality of materials should be dispensed with. It is intended only to refer to

the matter of controlling the proportions and consistency. The determination of the proportions for each class of concrete was exceedingly simple, as it was done by trial with the first few batches. None of the computations usually considered a necessary part of the scientific control of concrete were resorted to. Subsequent minor changes in proportions were made entirely by the concrete foreman. The water-measuring device was set, with the proper allowance for moisture, by the Architect's representative. The only duties performed by the testing organization as a part of the control of the concrete consisted of making the moisture determinations on the aggregates. This could have been done by any intelligent man.

In summing up, it was proven that the use of the water-cement ratio specifications, with a minimum of supervision, permitted the contractor to deliver concrete consistently stronger than that specified, and yet save a worthwhile amount of cement. It enabled the contractor to use the most economical mixes both from the standpoint of the cost of materials and the cost of placing. It enabled him, partly because of good forms, to save money by almost eliminating patching. It made the desires of the owner and the contractor coincide, and thus eliminated costly disputes. All this was gained, or can be gained, with no more supervision than is given to the average job. A good Architect's representative, an experienced construction superintendent, and an intelligent concrete foreman are able to supply all the technical talent needed, without really interfering with their other normal duties.

New Officers and Program for Illinois Products Association

February 26 was a great day for the Illinois Concrete Products Association, for on that day the association was given a new start toward activities that seem destined to bring the organization to the front as one of the most successful state organizations in the country.

Since the former president, John Powers, was elected that week as president of the National Association, the organization elected as president another man who has done great things for the industry and whose work has been adjudged a success—Edgar Otto, mayor of Downers Grove, Illinois, engineer, contractor, products manufacturer, and salesman of concrete masonry houses. John Powers, of Sterling, Illinois, was elected vice-president, since his new duties as head of the National Association would not permit him to head the State Association as well. H. E. Buchholz, of 1129 Garfield St., Oak Park, Illinois, was elected secretary-treasurer. The latter officer is a successful contractor, realtor, and concrete products manufacturer—one of the most successful in the country. He was one of the first to see the necessity of a real sales organization as a necessary and primary part of a products business. His own sales organization has proven a real force in promoting concrete masonry homes in the district.

The program of the new administration is an ambitious one. The new secretary has arranged to devote a considerable portion of his time to organization affairs. An active campaign has been outlined on building code revision and enforcement, on fire insurance rates, on better building loan arrangements and terms from the bankers, on securing certificates of quality for a maximum number of producers, and to obtain a hundred new members for the state organization and for the National Association. Products manufacturers will be sold on the idea of more constructive and active sales efforts and upon the other principles that are working to the benefit of products manufacturers elsewhere.

Pre-Cast Slabs on Grade Separation

The Illinois Central Railroad Is Using Pre-Cast and Poured Concrete Extensively on Their Electrification Work South of Chicago—Minimum Delay of Traffic—A Big Casting Yard—Great Slabs Handled by Crane

As part of the program of electrification, the Illinois Central Railroad is carrying on extensive elevation and grade separation work on their lines near Chicago. This work, together with the establishment of a new yard, calls for numerous concrete viaducts and several bridges. Because of the fact that heavy traffic is handled on these lines it was found impracticable to delay things long enough to use ordinary methods of concrete construction. In order that no track should be out of service for any but the shortest possible time, resort was made to the pre-cast concrete slabs that have been in use by the road for many years. These had recently been improved in design after a lot of experience, and the engineers were certain that satisfactory results could be gained.

The abutments and piers were cast in place without disturbing traffic. As fast as they were ready for loading the track would be taken out of service and the new slabs placed by means of a big 50-ton derrick car run up to the work on the track being replaced. Flat cars loaded with the slabs were spotted on the adjoining track, utilizing time when that track was not required for other service.

These slabs, some of them weighing from 35 to 50 tons, were bedded on the abutments and piers on a $\frac{3}{4}$ -in. bed of stiff mortar, separated from the bridge seat by a layer of tar paper. This construction affords good bearing, it has been stated, and at the same time allows sufficient joint to take care of any expansion that might occur in the slab.

These slabs are being made by the contractor, Bates & Rogers, under the supervision of the railroad, in a big casting yard that has been established for the purpose at 171st street. Wooden platforms and wooden forms are used in casting these units, and each unit is placed to be easily reached by the railroad crane that loads them onto the flat cars for delivery to the job. These slabs, made according to A. R. E. A. standards, are left to age for sixty days before going out to the work. At the end of



Here is a slab being picked up off the car and being swung into position on one of the subways. These structures are designed for Cooper's E-60 loading. Impact is figured on the basis of one-half live load squared over the dead load plus live load

21 days, however, they may be picked up and stood out of the way on their sides, to make room for the casting of more units.



The casting yard where the slabs are manufactured for the work. Note the wooden casting platforms between the tracks, the massive size of the units, the reinforcing cages to the left, and the wooden forms that are used. The large crane is seen loading a unit onto the flatcar for delivery to one of the jobs



A closeup of the equipment used to lay these 50 ton concrete units. Its rated power is often required on this work

Some idea of the speed of these operations may be gained by knowing that any one track is not out of service for more than three days on any one of these structures. One day is required for the laying of the units, while the rest of the time is required for preparation, waterproofing, and ballasting the new track.

The same road is using pre-cast concrete cribbing for making small temporary retaining walls, and concrete fenceposts on several parts of the lines. These latter units have been giving trouble in the past, due to the fact that the reinforcing would often be too close to the surface. The engineers solved this matter, however, by getting forms for the next larger size posts and retaining the reinforcing called for in the smaller post. By this means the steel would be ordinarily adequately protected by the concrete and better success obtained.

Concrete Cribbing Used on Illinois Central Improvements

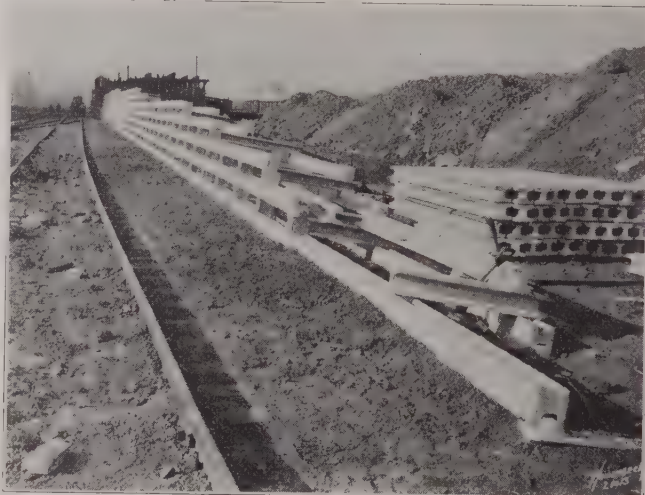
A form of precast reinforced concrete cribbing, recently described in CONCRETE, has been in use by a number of railroads throughout the country for the construction of temporary and permanent retaining walls in cuts and fills and in the construction of wing walls and similar work.

One prominent user of these units is the Illinois Cen-

tral Railroad, particularly near its Chicago terminus. On this part of the line, in connection with current work as part of the scheme of electrification, a great many of the units are being utilized as part of temporary work. Of interest is the retaining wall recently constructed near the 22nd Street Station on the suburban lines, near the 67th Street Station, and at other points along the road.

These units are being tried out by the railroad because of their economy. Because of their design they are easily laid by common labor, and are completely salvageable when no longer needed at their present location. There are only two units, made of reinforced concrete, consisting of the header and the stretcher. No pillow and filler blocks are used. There are no mortar points or galvanized dowels to call for skilled labor. It has been found, say the manufacturers, that the units interlock automatically and without trouble.

These units, manufactured by the R. C. Products Company, Inc., 1048 Engineers Building, Cleveland, are also proving quite useful to road contractors on grading work, bridge approaches and wing walls, and on grade separation work, and to building contractors in cribbing as well as for the erection of temporary ramps and other temporary work. As a retaining wall for high terraces these units have proven economical and permanent, as they afford good drainage without allowing earth to sift through the interstices.



The face side of the south wall, looking north, from the south end, near the same station. Notice how the wall is easily laid up using but two types of units

Water Content in Alumina Cement Concrete Important

Experiments just completed at the Bureau of Standards at Washington, show that the old rule to use the least possible amount of water that will make concrete workable is just as applicable for producing great strength in the new quick-hardening high-alumina cement, as it is with concrete made from portland cement. In one experiment, a decrease of 1% in the amount of water used was found to increase the strength of the concrete as much as 26%. A gravel concrete made with the new quick-hardening high-alumina cement generally develops as high a strength in twenty-four hours as a portland cement concrete would develop in twenty-eight days. This quick hardening feature is particularly valuable where delays in waiting for the concrete to harden and attain its strength are costly.



The rear end of the south wall, looking north, on the Illinois Central job near the 22nd Street Station, Chicago

EDITORIALS

Profitable Control

In this issue appears a paper read by F. R. McMillan at the recent convention of the American Concrete Institute. It shows how the concrete in the new home of the Portland Cement Association was mixed and placed under strict laboratory control. The concrete was uniformly stronger than specified. The absence of honeycombing indicated good workability. The very methods that afforded concrete of a high quality were methods that afforded real economy in the use of cement and aggregates and in placing. The secret of this economical and strong concrete lay in the use of a water-cement ratio strength specification.

The contractor was able to save money because his cement factor was conspicuously low. He was able to save money because he was able to so proportion his aggregates that the most economical mixture was produced. He was able to save money because his proportions could be adjusted so as to gain the desired workability. Yet with all this economy his mixes were so designed as to give strengths that were as high, or higher than if he had used more cement in a thinner mixture.

The complete character of the observations will convince many a doubter that regardless of theory, the matter of profit alone will justify a trial of this type of job control.

How Strong?

How strong should we make a concrete block? That is the question that is absorbing the attention of products producers everywhere. Shall they be made just strong enough for foundation work, should they be made just strong enough to use in walls up to one, two, three, or four stories in height, or should they be made two, three, or four times as strong as actually may be needed? How much strength should be added to account for manufacturing variations? Those are questions that are being debated on every hand. Again, should block be made so as merely to meet code requirements safely, or should block be made considerably stronger?

Code requirements are usually fixed at 700, or 800 or 900 pounds per square inch of gross area. These strengths are thought to be sufficient for foundation work and for use in walls of one and two story dwellings. Higher strengths are to be gained only at a higher cost, under present manufacturing conditions.

The argument for the stronger units is largely based on the merchandising value of unquestioned strength and the opportunity of securing a quality price for a quality product. On the other hand, low cost production demands the manufacture of units that live up only to the code requirements.

As long as some manufacturers in any line believe in selling quality at a good price while others prefer to sell on a strictly price basis, it is difficult to see any real settlement of this age-old problem in the products field.

Block must continue to be manufactured and sold upon the basis of a wall cost as low or lower than is available with other permanent construction of equal or greater strength. In settling the question of strength the main fact to be considered is that the units should lay up in a

wall at a cost no higher than other masonry, and produce a wall as strong or stronger, than any wall with which the block wall is able to compete.

Somewhere between the minimum strength required to produce the right kind of walls, and the maximum strength consistent with a competitive selling price, lies the middle ground upon which block makers and building officials should be able to agree.

The exact figure which represents this strength is perhaps still open to discussion, but we strongly suspect that it will be worked out eventually as a variable dependent somewhat upon the type of structure for which the block in question are intended.

Florida Rumors

Many of our readers have probably heard rumors to the effect that much of the concrete block construction in Florida is of the shoddiest sort, and that the block themselves are generally of pretty poor quality. As an answer to these rumors, we are glad to be able to publish in this issue an article by a competent engineer who has just returned from a trip of inspection of the more important building projects of Florida.

His article reveals both the source of the rumors and the true condition of affairs. It is true, he says, that block are being delivered to the job in very green condition, but it also is true that the Florida climate provides unusually favorable conditions for curing the block on the job. As most of the block being used are well made from fairly satisfactory aggregates with an ample proportion of cement, they cure into as good walls as are apt to be found anywhere. The singular freedom from crazing which he observed would seem to indicate both a high quality of block, and natural curing conditions on the job as good or better than are often provided artificially.

The plain facts of the situation seem to be that the concrete products manufacturers of Florida are turning out an honest product with the greatest speed consistent with the maintenance of high quality. To this end they are taking every advantage that conditions offer, so long as they can do so without detracting from the ultimate strength of the structures into which their block go.

Since the final results seems to justify this course, we can see no legitimate grounds for criticism on the part of those not familiar with the peculiar conditions existing in Florida. The whole story seems highly creditable to the men of the concrete products industry in that state.

Reims Cathedral

One of the greatest of man's works in natural stone—Reims Cathedral—is being restored to its original condition by the use of precast units of artificial stone. The years of effort undone by a few high explosive shells are being replaced by a few months' work in concrete. There's a certain fitness in this, that the noblest monument that an age of beauty has left to us, should be saved through the resourceful engineering that is the greatest art of our own age. And it is worth noting that this work of restoration has called forth a skill and ingenuity of a rarely high order—fit indeed to match against the beauty which it serves.

A Detroit Centrifugal Pipe Plant

Superior Sand & Gravel Co., Detroit, Adds Centrifugal Pipe to Its Products—How the Pipe are Made by the Nichols Process

The Superior Sand and Gravel Co. has come to be a very important factor in the concrete products business in Detroit. Originally organized in a rather small way to market just those products which give the company its name, it has undergone repeated expansion—first into a general builders' supply business, then into manufacturing.

The first step in this later development was when the company acquired a yard with a rather poorly equipped concrete block plant. This was improved with new equipment and better methods; another plant set up on the other side of the city for producing block and structural tile and lastly and for many reasons of greatest local consequence the company went into the concrete pipe business in a thorough and aggressive way.

It had to be aggressive and it had to be thorough because concrete pipe was never much of a factor in the Detroit market. Competitive materials held sway, and that, almost paradoxically, without much competition. Since Superior entered the pipe market and established beyond any argument the quality of its product and the intelligent thoroughness of its manufacturing policy, sewer pipe has been costing the city of Detroit much less.

Because of this general background, more than ordinary interest attaches to the latest development in the pipe business—the manufacturer, first experimentally, then under commercial production of Nichols centrifugal pipe.

About 4,000 feet of this material is going into a new Oakland county drain and about 1,700 feet of it into a Henry Ford property development.

The manufacture of pipe and poles by centrifugal processes has had practically world-wide development and the United States patent office has issued nearly 500 patents which bear remotely or closely, directly or indirectly on the subject.

C. R. Nichols began working out his ideas on the subject several years ago in Texas and made considerable pipe in that state. In the summer of 1925 he set up a manufacturing unit at the plant of the Superior Sand and Gravel Co., Detroit.

Product a Success

Production of Nichols pipe thus far indicates that it will be a big factor in the market for the larger diameters



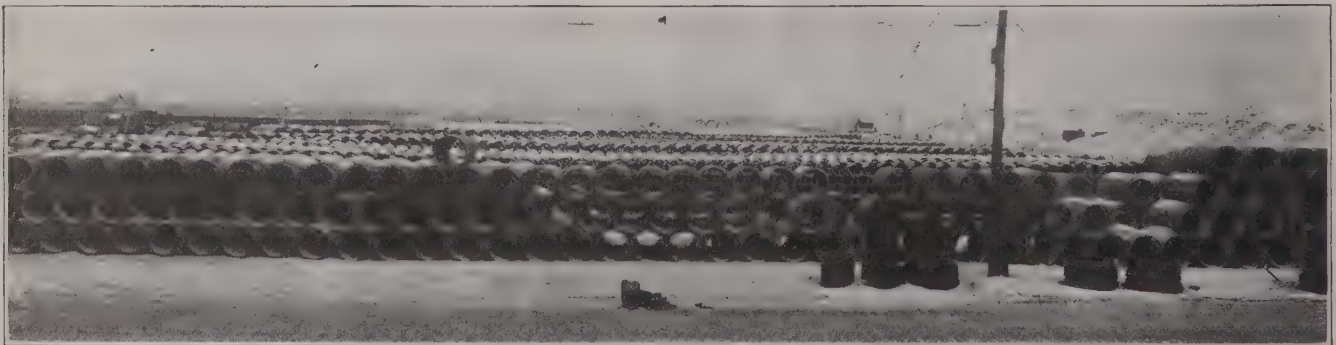
One of the one-piece pipe molds and a few of the pipe. The plant is in the background

in sewer work and that it can be made to meet all ordinary requirements as a pressure pipe for water. Operations at the Superior plant show that for pipe of the 24-inch diameter and up, the new centrifugal pipe is as strong as the company's other machine-made pipe and manufactured at less cost for materials. The present Superior plant was not designed for its production, but estimates based on several months' experience also indicate a labor cost saving as well. As licensees under the patents of the Nichols Centrifugal Products Corporation, the Michigan licensees have contracted to build a plant of 100 tons per day capacity especially for the production of Nichols pipe, and to have it in operation by the end of this year.

Making this pipe differs in several important features from other centrifugal processes.

Of first importance perhaps is the use of a steel shell or mold in one piece instead of one made of two or more sections.

Steel shells for centrifugal pipe production in lengths up to 12 feet and diameters up to eight feet are necessarily heavy and cannot under manufacturing conditions be handled gently. Two-piece shells frequently suffer just enough wear and tear so that they do not fit snugly enough on their longitudinal joints to form a perfect seal against the tremendous pressure of the contents, thus permitting outward extrusion of water when revolved at high speed.



The pipe occupying the foreground of this Superior plant stock yard are all Nichols Centrifugal—in half lengths, 6 ft. long, made two at a time in the 12 ft. cylinders

One-Piece Shell

Some of the extreme densifying advantages of centrifugal force are lost if the restraining outer shell leaks. In adopting the one-piece shell, Mr. Nichols sought to avoid seams in the concrete at these two longitudinal joints—seams which bring pipe failures at much less than the loads pipe would otherwise carry. This seam weakness is due to the escape of water, which in the absence of a leak goes to the center of the mold through the very nature of the centrifugal force which throws the heavier material to the outside.

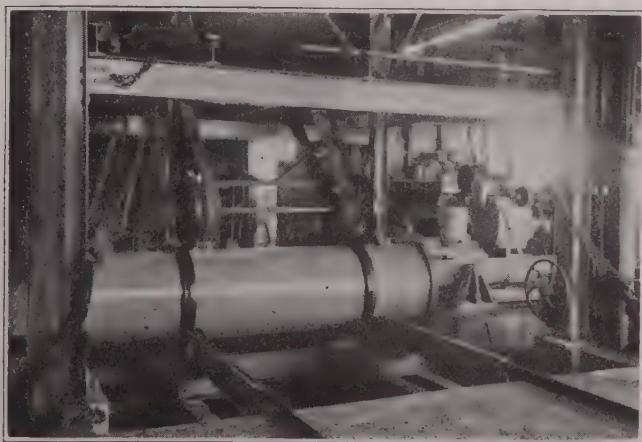
To permit easy release of the centrifugally formed concrete pipe from the mold, a method is employed which is unique and singularly peculiar to the Nichols process. The interior surface of the form is coated with a thin layer, say 1/16-inch of fusible material such as paraffin. Under the temperatures maintained in the steam curing kiln this coating becomes fluid, thereby leaving in its stead an annular space which of course frees the concrete mass from the interior surface of the form and thereby permitting an easy removal from same.

The mold is spun, supported on four idlers, two at either end and driven contrary to usual practice, from above by rubber-tired driving wheels, the shaft on which they run supported by a movable, overhead framework which lifts back out of the way.

High Speed Spinning

A point emphasized by Mr. Nichols is that this method of driving, coupled with a mold whose rings are very true, permits a very high speed without jumping and chattering. Chatter, in centrifugal casting, has a tendency to destroy the densifying effect of the centrifugal force and develops weakness or sometimes completely shatters the shell of concrete being formed.

One of the handicaps of centrifugal casting has been in its tendency to cause segregation of materials. This tendency is very largely overcome by the use of a minimum of water in the mix. With a stiff mix, however, it has been very difficult to get an even distribution of the concrete. In the Nichols equipment this problem has apparently been solved by two devices. The first is the trough with spiral flight conveyor which takes the concrete from the mixer. The trough bottom travels mechanically through the cylinder, depositing the concrete with a great deal of accuracy. Concrete may be used successfully with less than three gallons of water to the sack of cement, a mix so stiff that the spinning of the mold will not distribute it laterally more than six inches.



Nichols Centrifugal Pipe Machine at the plant of the Superior Sand and Gravel Co., Detroit, Michigan



The loading end of the mold and the trough through which the concrete is deposited by a worm conveyor. Above is one of the two rubber tired drive wheels

Spreading the Mix

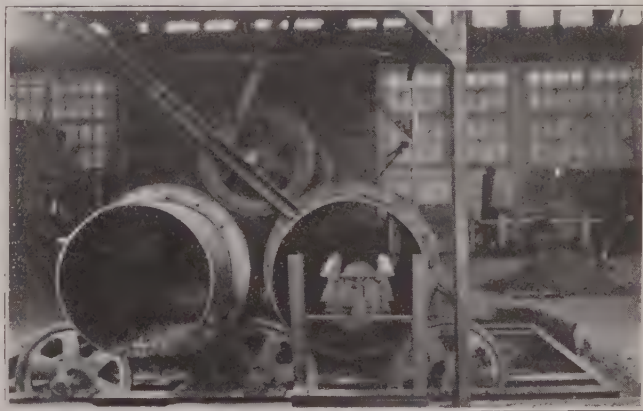
To aid the proper spreading of the concrete is the second device which is a combined trowel and sweep, shaped to the curvature of the pipe, worked through the mold mechanically. This device is used first to trowel and sweep the mix into place and then as a strike to skim off excess water and the light, soft material or slurry that works to the inner surface during densification and the removal therefrom.

This method of placing the concrete and controlling the thickness of a stiff mix has another important result. The concrete is kept evenly balanced throughout the shell. This almost perfect balance greatly minimizes jumping and chattering with their shattering effect.

Mr. Nichols makes the claim for his process that it makes possible the use of aggregates which would not ordinarily be suitable for concrete cast centrifugally. With a speed range up to 5,000 peripheral feet per minute, clay, coal, chips, shells and other weak elements often found in aggregate can be handled and successfully eliminated and by proper adjustment of speed at the various stages of casting to the nature of the aggregate and the character of the mix a coarse aggregate can be used successfully.

Curing the Pipe

When a pipe has been cast, the driving wheels are lifted out of the way, a chain hoist lifts the cylinder until it



A twin set-up for making Nichols Centrifugal Pipe in Dallas, Texas

rolls away on a track into the curing room.

At the Superior plant no special curing methods, other than those used for machine pipe, have been provided, although there has been a fine degree of control of moisture and heat in curing. Every curing room in the Superior pipe plant is equipped with a recording thermometer. With the steam heat a water spray is due to be turned on night and day at regular intervals. The drop in temperature that comes with the spray makes its own clear record which is reviewed and checked up in the office each day.

In fact, Superior plant operations, with constant sieve analyses and strength tests, suggest that degree of control which is desirable and possible in the manufacture of concrete products as in other well developed manufacturing lines. As a further aid to definite knowledge of the work of the plant a large testing machine is being especially built for the Superior to handle full size pipe sections. E. H. Bingham, General Manager of the Superior Sand & Gravel Co., is not an office manager. He spends little time in the company's office in the Dime Bank Building—most of it is out where the work of the organization is being done. R. A. Foley is in immediate charge of the concrete pipe development for the company.

Reduce Sizes of Spirals and Bars at Hoover Meeting

A program for simplifying specifications for steel reinforcing bars was mapped out, four sizes of steel spiral rods used as cores for reinforced concrete columns were adopted as standard, and the eleven recognized sizes for steel reinforcing bars in cross-section areas were approved for continued use, at meetings of the industry and trade on January 26 at the Department of Commerce.

A group meeting with Secretary of Commerce Hoover under the auspices of the National Committee on Metals Utilization and representing the steel reinforcing bar industry adopted a resolution, after extended debate, requesting the appointment of a committee by the Department of Commerce to make a survey of what grades of new billet concrete reinforcing steel are most desirable. Under the terms of the resolution the committee will conduct a referendum and report at a general conference to be held next October.

The discussion disclosed much sentiment in favor of eliminating some of the 57 specifications which are now in existence. W. C. Wetherill, director of the metals utilization committee, presided at the meeting and read communications from representative distributors and users endorsing the proposal for simplifying the specifications. A. E. Lindau, chairman of the committee on grades of reinforcing steel and standard sizes, of the Concrete Reinforcing Steel Institute, outlined the position of that organization.

Simplification of specifications and universal adoption of a suitable standard grade of reinforcing steel offers a potential saving of \$5,000,000 a year to the construction industry, said Mr. Lindau. He reviewed the development of reinforced concrete construction and its rapid growth in urban areas where storage space for materials and where handling presents serious difficulties. The business handled through distributors, said Mr. Lindau, now amounts to more than the entire consumption of steel 20 years ago, while the total use of steel reinforcement has increased from 80,000 to 700,000 tons a year.

Mr. Lindau presented statistics showing that approximately 100,000 tons of new billet steel are carried in stock to meet the present demand. He explained that during the war, in order to conserve the supply, distributors compromised on a single grade but that this advantage has

been lost to the building industry. He predicted that conditions will become steadily worse unless a single grade of steel again is adopted.

Other speakers who addressed the meeting were F. E. Hughes, of the Franklin Steel Works, Franklin, Pa., who is president of the Rail Steel Products Association; E. F. Kinney, of the Bethlehem Steel Co.; R. H. Dalglish, of the American Electric Railway Association; D. H. Sawyer, of the Associated General Contractors of America; S. A. McAllister, of the Bureau of Standards; Dr. G. H. Burgess, chairman of the Federal Specifications Board; C. E. Skinner, of the American Engineering Standards Committee; Richard L. Humphrey, of the American Society for Testing Materials; H. Farnham, of the Pennsylvania Railroad, and O. L. Irwin, of the Truscon Steel Company.

The steel men asserted that in seeking the adoption of a single standard they are not pleading alone in their own interest but foresee similar benefits to related industries resulting from increased efficiency and economy in the use of steel. They pointed out that in view of the time that necessarily will be required to change existing specifications the sooner the problem is settled the greater the economic saving will be.

The recommendation that four sizes of steel spiral rods should be adopted to replace the seven sizes now in use came from a meeting of manufacturers and distributors held under the auspices of the Division of Simplified Practice of the Commerce Department. The report endorsing the reduction in sizes was presented by Mr. Lindau, who stated that the recommendation was based on studies made by the Concrete Reinforcing Steel Institute. The conference voted that the recommendation shall become effective December 15 next, and that existing stocks of old sizes shall be cleared, if possible, by March 1, 1927.

When the list of 11 sizes in cross section areas, adopted September 9, 1924, came up for revision, the conference voted to continue the same in effect. It was reported at the meeting that the use of the standard list has been very general and that state highway departments, public works departments, and municipalities have written these sizes into their specifications. They have also been recognized by the federal government.

Georgia Studies Effect of Calcium Chloride

Because there are conflicting opinions on the effect of calcium chloride on concrete when used as an admixture, the State Highway Department of Georgia is undertaking an investigation of its own in order to determine just what does happen. Aside from the question of increased or decreased strength, they wish to establish the effect of calcium chloride upon the setting time of concrete in which various brands of cement are used. It is hoped to determine whether or not the admixture will cause some cements to set so rapidly as to interfere with the proper finishing of concrete pavements with the machine finishers.

New Products Firm in Ohio City

The Anchor Concrete Products Company, with a nominal capital of \$500 has been incorporated in Cincinnati, Ohio. The company will take over a going concern of concrete block manufacturers, which formerly had been conducted as a partnership by E. Feldkamp and Loyal S. Martin. The incorporators are E. Feldkamp, Loyal S. Martin, O. K. Jones, Bernard J. Kilday, and Ruth McConnell.

Alumina Cements and Sulphate Water

Tests Made at Minnesota Drain Tile Laboratory Show That Drain Tile Made with High Alumina Cement Are Unaffected by Sulphate Water at the End of One Year

By DALTON G. MILLER

Drainage Engineer, Bureau of Public Roads, U. S. D. A.

So much has been said and written in recent months relative to the use of high alumina cements for special purposes that results of various tests which have been made in the Cooperative Drain Tile Laboratory dealing with cements of this type are at this time perhaps of more than passing interest.

The primary object of all these tests has been to determine the resistance of different brands of high alumina cement to sulphate waters and while this phase of the work has not yet progressed to the extent that permits drawing definite conclusions, some of the results that have been obtained along this line are presented.

High alumina cements, as is now quite generally known by most engineers, are cements much higher in alumina and iron than standard portland cement. High alumina cements were first developed in France and the general chemical composition of French high alumina cements as given by Jules Bied are shown in Table I, while for comparison purposes the average results of analyses made by Richard K. Meade of a great many American-made portland cements are also tabulated. Such analyses as are at hand of Atlas Lumnite cement, the only American brand of high alumina cement now on the market, differ to some extent from the results given by Bied, but in general are characteristically similar.

TABLE I.

COMPOSITION OF FRENCH HIGH ALUMINA CEMENTS
COMPARED WITH THAT OF AMERICAN
PORTLAND CEMENTS

	High Alumina Cements (French) per cent	Portland Cements (American) per cent
Silica (SiO_2)	10-12	22
Alumina (Al_2O_3)	40-45	7.5
Iron Oxide (Fe_2O_3)	15-20	2.5
Lime (CaO)	35-40	62

High alumina cements are made from limestone and the mineral bauxite which is high in alumina and iron, while standard portland cement, as is well known, is made of combinations of limestone and clay or shale, marl and clay or of limestone and blast furnace slag. The raw materials entering into high alumina cements are therefore essentially different from those of which standard portland cements are made. There is also some difference in manufacturing processes which will not here be discussed.

The one property common to all high alumina cements of greatest interest to engineers is their rapid hardening, although the time of initial and final sets does not greatly differ from that of portland cement. The gain in strength of high alumina cement concrete is so rapid between 12 and 24 hours that at 24 hours, under ordinary conditions, it may safely be assumed to have both tensile and com-

pressive strength at least as great as standard portland cement at 28 days. High alumina cement concrete and mortar apparently reaches its ultimate strength very early so that tests at 7 and 28 days and at 1 and 2 years closely follow a straight line. It is obvious that this characteristic could be made use of to great advantage in several ways in the manufacture of drain tile.

Steam Curing of Alumina Cement

Inasmuch as such excellent results have been obtained with standard portland cement in the matter of developing resistance to sulphate waters by steam curing in a temperature of 212 degrees F. a series of tests were outlined (1) to show the effect on strength of curing high alumina cement cylinders in water vapor at temperatures of 100 degrees F., 155 degrees F., and 212 degrees F. and (2) to determine the relative resistance of these variously cured specimens to the action of sulphate waters.

The work to date indicates that no strength whatever is gained by curing in steam concrete or mortar made of high alumina cement while, on the contrary, in all cases a loss of strength resulted except for those specimens in Series 144 and 149 cured in water vapor at 100 degrees F. Cylinders in these two series developed about the same strength as those of Series 143 and 148 cured 72 hours in the moist closet. It seems fair to conclude then, in the case of "Ciment Electrique," that steam curing is detrimental from a strength standpoint. It is not probable that other brands of high alumina cements would give materially different results along this line.

Sulphate Exposure Tests

After one year in the sulphate waters of Medicine Lake, South Dakota, 70 of the high alumina "Ciment Electrique" cylinders from 14 series, variously cured, had an average strength of 119 per cent as compared with specimens from the same series stored in tap water in the laboratory, while 50 Ottawa Sand mortar cylinders from 10 series had an average strength ratio of 110 per cent. The Atlas Lumnite concrete cylinders of Series 208, after 1 year in Medicine Lake, were 118 per cent as strong as cylinders stored in tap water in the laboratory. Needless to say these comparative tests at one year leave little to be desired for the cylinders in Medicine Lake. Just why the strength ratio should be so high is hard to explain but may possibly be due, at least in part, to the generally lower temperature of the lake water as compared with that of the laboratory tank for, as has been shown, the reaction of high alumina cement concrete to steam curing is considerably different from that of standard portland cement. Also it has been noted¹ that both the initial and final set of Atlas Lumnite cement is materially shortened by reduction, within certain limits, of the temperature of the curing medium, which is contrary to the action of standard portland ce-

Extracted from University of Minnesota Paper No. 597, Journal Series. This paper was presented before Minnesota Surveyors' and Engineers' Society, St. Paul, Minnesota, February 4, 1926. The report is based on experiments at University Farm, St. Paul, Minnesota, in the Drain Tile Laboratory conducted by the Department of Agriculture of the University of Minnesota, the Department of Drainage and Waters of the State of Minnesota and the U. S. Department of Agriculture.

¹ S. L. Meyers. *The Set of Lumnite Cement*, CONCRETE, Vol. 26, No. 3, March, 1925.

ment. It may be that this temperature factor is effective for so long a period as a year when the specimens are kept moist. It is of course also possible that the sulphates of the lake water may have had some accelerating influence in developing strength. Just what the ultimate outcome will be can only be learned through later tests.

In Table IV are shown 1 and 2 year comparative tests of "Ciment Electrique" concrete cylinders stored in the laboratory in tap water and in a 1 per cent solution of sodium sulphate (Na₂SO₄). In the case of these cylinders, unlike those stored in Medicine Lake, the temperature factor need be given no consideration as the temperature at all times has been identical for both groups of cylinders. It will be noted that at 1 year the strength ratio of the cylinders in the sulphate solution was 101 per cent but at 2 years had fallen to 75 per cent. There was, however, no appreciable surface action on any of the cylinders in the sulphate solutions at 2 years nor is there any at the present time (2½ years) and furthermore the average increase of length for the group has been less than .0004 inch. All of which indicates that final judgment as to resistance to sulphate waters of this particular brand of high alumina cement should be suspended until later tests.

Mixtures of Lumnite and Portland

Some of these earlier tests indicate that possibly high alumina cements may in general show considerable resistance to the action of sulphate waters. At present though the price of Atlas Lumnite is about three times that of portland cement and consequently the thought is suggested that a mixture of Atlas Lumnite and portland cement might have considerable merit for use in sulphate waters while at the same time the cost of the concrete might be reduced to a point where it would be feasible to use for drain tile. With this idea in mind cylinders were made

TABLE II.

COMPRESSION TESTS OF "CIMENT ELECTRIQUE" CONCRETE AND MORTAR CYLINDERS EXPOSED TO THE SULPHATE WATERS OF MEDICINE LAKE, SOUTH DAKOTA, COMPARED WITH CYLINDERS STORED IN THE LABORATORY IN TAP WATER. EACH INDIVIDUAL RESULT IS AVERAGE OF FIVE CYLINDERS MADE ON DIFFERENT DAYS

Series No.	Pounds per Sq. In. at 1 year-----		Strength Ratio
	Tank Specimens	Lake Specimens	
<i>Concrete:</i>			
137	2830	3400	120
138	2860	3320	116
139	2640	3790	144
140	2730	3790	139
141	3020	3670	121
147	4560	5220	114
148	5310	5960	112
149	5240	5450	104
151	2840	3650	129
152	5100	5040	99
153	5120	6280	123
154	5450	5620	103
155	4570	5770	126
156	4380	4960	113
Average for 70 specimens-----			119
<i>Ottawa Sand Mortar:</i>			
132	2760	2790	101
133	2080	2900	139
134	2440	2840	116
135	2650	2590	98
136	2630	2580	98
142	3590	4060	113
143	4220	4310	102
144	3750	4490	120
145	2780	2620	94
146	2500	3010	120
Average for 50 specimens-----			110

TABLE III.

COMPRESSION TESTS OF ATLAS "LUMNITE" CEMENT CONCRETE 2x4 INCH CYLINDERS OF SERIES 208 AFTER ONE YEAR'S EXPOSURE TO THE SULPHATE WATERS OF MEDICINE LAKE, SOUTH DAKOTA, COMPARED WITH TESTS OF CYLINDERS FROM THE SAME BATCHES STORED IN TAP WATER IN THE LABORATORY. ABSORPTION TESTS OF THESE CYLINDERS AT 21 DAYS GAVE 4.87%. EACH RESULT IS AVERAGE OF FIVE 2x4 INCH CYLINDERS MADE ON DIFFERENT DAYS

Age	Tap Water		Medicine Lake, South Dakota—	
	Per Sq. Inch		Per Sq. Inch	Str. Ratio
1 week	6360 lbs.			
4 weeks	6500 lbs.			
52 weeks	6260 lbs.		7420 lbs.	118%

TABLE IV.

COMPRESSION TESTS OF "CIMENT ELECTRIQUE" CONCRETE 2x4 INCH CYLINDERS OF SERIES 70 STORED IN THE LABORATORY IN 1 PER CENT SOLUTIONS OF SODIUM SULPHATE COMPARED WITH TESTS OF CYLINDERS FROM THE SAME BATCHES STORED IN TAP WATER. ABSORPTION TESTS OF THESE CYLINDERS AT 21 DAYS GAVE 7.07 PER CENT. EACH RESULT IS AVERAGE OF FIVE 2x4 INCH CYLINDERS MADE ON DIFFERENT DAYS

Age	Tap Water		1% Sodium Sulphate—	
	Per Sq. Inch		Per Sq. Inch	Str. Ratio
1 week	3490 lbs.			
4 weeks	4700 lbs.			
52 weeks	3790 lbs.		3820 lbs.	101%
104 weeks	4060 lbs.		3040 lbs.	75%

TABLE V.

COMPRESSION TESTS OF CONCRETE CYLINDERS MADE WITH VARIOUS ADMIXTURES, AS INDICATED, OF ATLAS LUMNITE AND PORTLAND CEMENT. EACH RESULT IS AVERAGE OF FOUR 2x4 INCH CYLINDERS MADE ON TWO DIFFERENT DAYS

Series	% of Lumnite	% of Portland	Water Ratio	—Compression Tests in Lbs. per Sq. In.—			
				1 day	3 day	7 day	28 day
381	0	100	.64	770	1780	2540	3710
382	5	95	.64	640	1570	2360	3640
383	10	90	.64	420	1460	2270	3610
384	15	85	.65	390	520	1530	3100
385	20	80	.66	590	650	1220	2750
386	25	75	.95	340	440	620	1240
387	35	65	.81	1370	1150	1400	2090
388	50	50	.75	2300	1790	1410	1760
389	75	25	.69	4510	4870	4120	3680
390	100	0	.59	6380	6420	7150	7190

and tested. It will be noted that some very peculiar results were obtained in these compression tests and evidently the possibilities of mixing Atlas Lumnite and portland cements are somewhat restricted although, within narrow limits, it may be feasible to do this if later tests of these cylinders in sulphate waters indicate that there is any advantage in so doing.

It was necessary to use so high a water ratio in some of the series in order to overcome a tendency of flash set that resulted with certain of the combinations. Because of this some of the compression tests of Table V are of little comparative value except as they show the practical limitations of combining high alumina and standard portland cements.

The portland cement used in these tests was a mixture of equal parts Universal and Northwestern States.

Data on Cylinders

The 2x4-inch concrete cylinders which constitute the majority of the specimens, were made with a well-graded aggregate the screen size of which was less than 3/8-inch. In all cases, the mix was 1:3 and the relative consistency 1. The water ratio for this consistency has averaged about .58. A 1:3 mix is as rich as is ordinarily used for drain tile, and it has been found by the laboratory work that a leaner mix than this is very much less resistant. A richer mix, while more resistant, is rarely used, as the cost of such tile generally is prohibitive. The relative consistency of 1 is as wet as can be used in machine-molded tile, and it has been found that consistencies greatly varying from this are considerably less resistant. In addition to the cylinders of concrete a number of mortar cylinders were made with standard Ottawa sand.

In all cases the mix used in the cylinders was proportioned by volume with the weight of cement assumed at 100 pounds per cubic foot. Each batch was mixed by hand at least 1½ minutes dry and 2 minutes after adding the water. The materials, after mixing, were tamped in three 3-gang brass molds in four layers, each layer being tamped 20 times. For tamping the laboratory standard cylinders a pointed rod was used which was 3/8-inch in diameter by 15 inches long; for the standard Ottawa sand cylinders a flat-ended 5/8-inch rod was used which weighed 337 grams.

Tests of Aggregates and Cylinders

The aggregate, obtained from the J. L. Shiely Company gravel pit at St. Paul, Minnesota, passed all standard physical tests, including a test for shale, which showed less

than 0.4 per cent by volume. The various sizes were separated by screening and recombined for each batch. The fineness modulus used was 4.67.

The standard Ottawa sand cylinders differed in no respect other than the aggregate from the standard concrete cylinders. As in the latter, the standard mix was 1:3 and the relative consistency 1.

Compression tests were made in a 50,000 pound Reihle machine, using a bottom spherical bearing block.

The absorption tests results are based on the A. S. T. M. standard absorption test for drain tile, which stipulates drying the specimen to complete dryness in a temperature of not less than 230 degrees F., followed by boiling for five hours.

Medicine Lake Water

Analyses of water samples taken from Medicine Lake at different seasons of the year showed a total salt content that ranged between 2.34 and 4.72 per cent, consisting almost entirely of a combination of magnesium and sodium sulphates in which the magnesium salt greatly predominates. The larger of these two figures represents water with a total salt content somewhat in excess of any soil water so far found in contact with any drain tile in Minnesota and is much more severe than is ordinarily encountered in agricultural lands anywhere.

Summary and Conclusions

1. Tests in the laboratory indicate that high alumina cement concrete reaches its ultimate strength at about 7 days and that thereafter the strength remains constant. To date no tests have been made beyond two years.
2. All tests of high alumina cement concrete and mortar cylinders, regardless of curing conditions, after one year's exposure to the sulphate waters of Medicine Lake, South Dakota, have shown an average strength ratio considerably above 100 per cent as compared with tests of cylinders from the same lots stored in tap water in the laboratory. The lowest strength ratio for any series has been 94 per cent and a ratio as high as 144 per cent has been obtained. The conclusions are based on tests of the French high alumina "Ciment Electrique" and on tests of Atlas Lumnite cement.
3. One series of the French high alumina "Ciment Electrique" stored in the laboratory in a 1 per cent solution of sodium sulphate (Na_2SO_4) had a strength ratio at one year of 101 per cent as compared with cylinders from the same group stored in tap water in the laboratory. Tests at two years were less favorable as the strength was but 75 per cent indicating a necessity for later tests before drawing any definite conclusions.
4. With the exception of specimens from two series none of the high alumina cement cylinders have shown any appreciable surface action. The two series in which surface action is very evident have been stored in the laboratory in a 1 per cent solution of sodium sulphate (Na_2SO_4) for nearly one year. These specimens were taken from distilled water and put in the solutions at 21 days without having been allowed to harden in the air. This would seem to indicate the same necessity for a hardening period for all high alumina cement concrete exposed to the action of sulphate waters as has been found so essential in the case of standard portland cement concrete.
5. All tests to date indicate that high alumina cement is perhaps somewhat more resistant to the action of sulphate waters than is most standard portland cement. It is not, however, 100 per cent resistant and later tests, after longer periods of exposure, must be awaited

before conclusions of any very considerable value can be drawn.

6. It is not feasible to mix Atlas Lumnite cement and standard portland cement except within very narrow limits.

Use of Sodium Silicate in French Highways

(From M. Guelle, in "Mines, Carrieres & Grand Enterprises")

By E. LEE HEIDENREICH

M. Guelle, engineer of roads and bridges at Besancon, gives the following information regarding the use of silicate of sodium in certain highways of the Department of Doubs:

Contrary to suppositions regarding silicated pavements, the soft limestones, even porous and crumbling, make better roads than the hard limestones.

As now, silicated roads in the Department of Doubs, last three to five times as long as the old limestone highways, the annual saving in maintenance amounts to from 56% to 88% in favor of the silicated roads.

This economical gain becomes even more important in regions like the Somme or the Champagne, where until now nothing but chalk had been available for repairs, and where up till now, hard materials for maintenance were brought from afar. M. Guelle has the conviction that in silicated roads even chalk may well be employed in repairs.

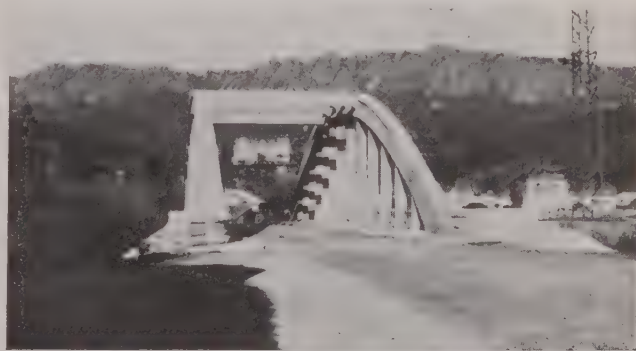
The principal advantages in silicated roads are:

1. Smooth and easy—particularly for automobiles—reducing repairs to vehicles.
2. A reduction in maintenance of 30% to 80% according to location and usage.
3. A minimum of dust and mud.
4. No influence by thawing, no softening.
5. Less noisy than ordinary roads.
6. The reduced maintenance results in fewer tie-ups for reconstruction.

In 1923 and 1924, the general council of Doubs allowed one million francs for the construction of silicated roads.

At the end of 1924, 30 kilometers had been finished. At the August, 1924, session of the general council, Chief Engineer M. Blaise decided to construct during the following three years all the main arteries of the department in silicated roads, more than 400 kilometers, two million francs being appropriated for 1925.

A Unique Highway Bridge



This reinforced concrete highway bridge carries tourist traffic over a stream on the famed "Corniche d'Or" route along the French Riviera. It is of a type that is often being tried today in Europe, but which is not so common in this country. A few of these, while expensive, would go a long way in dressing up our highways, replacing the girder type that is usually used over the smaller streams

Builds Concrete Gas Tanks

British Engineer Claimed to be Able to Erect Successful Tanks Economically, Making Them Gas Tight

In spite of the apparently overwhelming simplicity of its mixing and application, concrete is not yet a material that is fully understood, as witness the enormous amount of research in progress. Much of the prejudice which still lingers against its use is rooted, the writer is convinced, in certain errors of the early days from which disastrous results accrued, and it cannot be too firmly emphasized that even at the present time, when the construction of concrete works of all dimensions can at least proceed on fairly definite formulae, constructional schemes calling for the use of concrete in any volume demand the services of the specialist. This is particularly the case in regard to reinforced structures, the design of which is now recognized as a separate branch of building science. Various engineers who have distinguished themselves in connection with reinforced concrete have, as is well known, evolved special systems; and in the present note we propose to deal briefly with what is undoubtedly the most successful of these—we refer to the Economic system, the exclusive features of which are controlled by the Economic Structures Company, of 94-96A, Kensington High Street, London, W.8. This system has achieved considerable prominence of recent years when employed on certain large works, and especially in the construction of large storage tanks, in which branch of work Dr. B. N. Dey, D.Sc. (Engineering), a director of the Economic Structures Company, is an acknowledged authority.

The chief features of the Economic system include advanced scientific design on practical lines, resulting in real economy in the use of materials: every ounce of aggregate and reinforcement has its own special job. Labor-saving methods based on original ideas are employed, together with the most modern practice in the work of actual construction—the use of up-to-date mixing and pouring plant, shuttering, forms, scaffolding, and so on. Scientific management is applied to the work as it develops; the absolute safety of the structure is assured, and the speed of erection is accelerated. The Economic Structures Company is noted, by the way, for its excellent “staff work”: the whole plan of campaign is carefully thought out, and no chances are taken.

While the Company undertakes every form of concrete work, special attention has been paid by Dr. Dey to the peculiar problems involved in the construction of gas-tight and fluid-tight tanks; and here again the work of one man is focussing fresh interest upon methods which had previously been partially discredited through inferior work upon the part of poorly-equipped general contractors. Dr. Dey has shown that water-, oil-, and gas-tight tanks *can* be efficiently made in concrete, cost less in capital charges, cost next to nothing for maintenance, and have a practically indefinite term of useful life—when the Economic system is used. With such claims substantiated, the employment of steel or cast iron is clearly wasteful; it may be mentioned, for instance, that the Economic system was able to save the Glasgow Corporation approximately 30 per cent. upon the large reinforced concrete tanks (£200,000 installation) lately completed at Provan. This economy was the initial saving, and will be multiplied many times over while the tanks are in use, since nothing is needed for maintenance. The tanks were erected to Dr.

Dey's designs; they are gas purifiers, and the gas undertaking's technical advisers are completely satisfied with their performance.

Similar savings are being effected in connection with oil tanks and water tanks, the economy amounting in some cases to as much as 50 per cent. over the lowest cast-iron or steel estimate. Those of our readers having any connection with upcountry estates, oil-tank farms, and similar establishments, would do well to obtain a copy of Dr. Dey's degree thesis (based on 7 years' research and results of actual construction) on water-, oil-, and gas-tight concrete tanks, for which he was awarded the D.Sc. of Glasgow University, who recognized same as pioneer work. This is an invaluable original work, dealing exhaustively with the correct principles of tank construction. It affirms the necessity for correctly incorporated reinforcements, pronounces against the use of surface dressings as being merely palliatives, and shows that each tank must be treated as an individual problem. By their intensive study of tank construction the Economic Structures Company are naturally very well equipped to undertake such work: they are in a fine position to “deliver the goods,” and the fine performance of the hundreds of tanks they have erected in various parts of the world offers the best possible testimony in this connection. Reinforced concrete applied on Economic lines is undoubtedly the material of the future so far as large installations of storage tanks are concerned, and engineers are rapidly recognizing this fact.—*Anglo-Latin Traders' Review*.

Concrete Pile Tests in India

By A. C. BLACKALL

London, England

Important tests, which will be of interest to all localities in which the subsoil is unsuitable for supporting heavy loads, have been carried out by the East India Railway. They were the outcome of problems connected with the construction of new premises in Calcutta.

Upon a trial reach being excavated the subsoil was discovered to consist of filling—principally ancient bricks which had apparently come from the Old Fort—while water appeared at a depth of 9 feet. After careful consideration the engineers in charge of the work decided to experiment with Simplex concrete piles and to test a set of four. The cement used in the manufacture of the piles was the rapid hardening ferro-concrete (“ferro-crete”). Three of the piles had a length of 56 feet and the fourth of 51 feet. A sinkage of 1 foot for an average depth of 10 feet required from twenty-seven to thirty blows—according to the compression of the soil—of a two and a half ton hammer falling 38 inches.

Five days after the foundation cap had been concreted loading commenced, and a total of 230 tons was placed within the next twenty-one days. No appreciable settlement was recorded. It is claimed that the liquid concrete issuing from this type of driving tube cements itself to the surrounding ground, and so gives a high coefficient of friction on the sides of the piles.

Precast Concrete Rebuilds Cathedral Roof

In the Reconstruction of the Reims Cathedral, Partially Destroyed During the World War, a System of Light Weight Concrete Roof Trusses Plays an Important Part—Precast Units Used in the Reconstruction of the Roof Structure

A specially appointed commission has made an appropriation of 4,000,000 francs to the restoration of the Reims Cathedral from the generous gift of \$1,000,000 (about 18,000,000 francs), made to France by Mr. Rockefeller. In accordance with the wishes of the donor, this sum is to be devoted to the reconstruction of the roof over the nave and the choir and to that of the tower of the Angel (clocher a l'Angle) of that great structure. Only the work on the portion of the roof over the nave will be begun this year. The work was described in "L'Illustration," of which the following is an abstracted translation.

The outside appearance of the cathedral has not been changed in the reconstruction, but the buttresses have all been more or less rebuilt—on the north and south side and at the apses. The south wall facing the old archbishop's residence was relatively little damaged and, to a casual observer, its restoration may appear complete. However, the work of decoration has not as yet been begun. An interior view shows the reconstruction of the nave completed up to the choir. The trusses and gables of the north and south wings have been completed.

The Board of Directors of Fine Arts has entrusted the reconstruction of the cathedral to Mr. Deneux, Chief Architect of Historical Monuments. He, who is the inventor of a reinforced concrete truss system of exceptional value, was requested to tell of the way in which it is intended to accomplish the restoration.

Before describing the details of the present plan, Mr. Deneux points out the beauty of the old timber trusses, giving a brief description which can be easily followed by the lay reader.

Old Roof Structure

The Reims Cathedral had already withstood a disastrous fire at the end of the fifteenth century, when the original timber roof trusses were destroyed. Little indication is left in the present structure of the nature of these primitive trusses. The location of the nave trusses

is indicated by old stone brackets on which the trusses were supported, these brackets being spaced about four meters apart.

While a temporary roof was being built hurriedly, a collection was being taken to obtain the funds necessary to repair the damages. In 1483 the carpenter work was entrusted to Collard Lemoyne, an old-time master builder. The work progressed rapidly; in less than two years the tower of the Angel was rebuilt; one-half of the nave, the apse, the transept were built over. Collard Lemoyne probably died about this time, as other contracts were made with several master carpenters. The gables were finally completed in 1492. Thus, nine years were required to collect the necessary resources.

About twenty years later, in 1511, it was decided to build a tall central bell tower at the intersection of the transept supported by four massive stone arches. The



Reconstruction of the Reims Cathedral, rebuilding the roof over the nave. The beams and rafters of this framework are boards of reinforced concrete, very light and strong

*Translated from *L'Illustration*, October 24, 1925, by M. Arronet, Chicago, Ill.

footings at the base were 0.45 m. square and formed a rectangle 13.50 by 12.25 meters. The plans specified a height of 130 meters up to the top. This distance being measured from a point 45 meters above the floor elevation of the nave, the extremity of the cross would have been about 185 meters above the latter. This rather bold project was carried out only in the height of the gables. Either the resources gave out, or the church dignitaries hesitated at the last moment, overcome by the fear of possible lack of stability in this gigantic structure.

It was this truss structure that caught fire from the German shells on September 19, 1914. As will be seen from the description below, it was more than of casual interest.

The timber covering of the apse consisted of seven trusses spaced 3.54 m. center to center and of five half trusses. Each truss had a span of 15.35 m. and a cross section 34 by 34 cm. A system of ties and braces rendered the structure rigid, excluding every possibility of deformation. The different members were connected by means of wooden pins.

The tower of the Angel, located at the apex, was supported by the last truss, specially reinforced. It was octagonal in shape, projecting along the eight faces and seemingly supported by eight cariatides of carved wood covered with sheet lead. These statues, purely ornamental, were fixed to the pillars of the tower by means of iron bolts, the only iron elements to be found throughout the entire roof structure.

The system of trusses over the transept was designed in the same manner.

As to the portion of the roof over the nave, it represents two distinct types of timber work, greatly differing one from the other. Over one-half the length towards the transept Collard Lemoyne had erected a truss system similar to the above described, though of different dimensions. The rafters, made of single timbers, were 17.30 m. long and .22 m. square at the base. Due in all proba-



Reinforced concrete framework, north wing of the Reims Cathedral

bility to the difficulty of obtaining suitable timber, a simpler system was adopted for the remaining half of the roof over the nave, calling for thinner sections.

The upper gables thus represent a total of 1,520 cubic meters of timber; the lower gables of the wings and the radiating chapels totaled 500 cubic meters, the grand total thus being over 2,000 cubic meters—a load equal to 1,800 tons. The lead roof over the trusses weighed 400 tons, of which 250 tons were recovered after being melted by the fire in 1914. This will be used in the reconstruction work now going on.

The New Project

The intention is to reproduce in shape and general appearance the roof existing before the war. Plans were made first to make such repairs of the interior as would permit resuming of services; second, to restore the roof of the lower gables and erect a temporary reinforced concrete slab roof over the nave in anticipation of further funds for the reconstruction of this portion. In rebuild-



View showing bracing of the arches of precast units



Interior showing the spacing of the concrete arches

ing the lower gables, which are now completed, a new type of construction—a reinforced concrete truss system—was used which excludes all possibility of destruction by fire in the future. Other cathedrals have had their old timber trusses replaced: The wooden trusses at Chartres by steel and cast iron, those at Laon by steel and reinforced concrete, that of Laval by steel. The main gable at Rouen was rebuilt in cast iron; Clermont-Ferrand now has frames of masonry and steel.

The system adopted for the cathedral of Reims is altogether new and was used successfully in the St. Jacques Church in the same city. It consists in making the beams and rafters of boards of reinforced concrete, sufficiently light so that each construction member may be swung into place by one or two workmen without any erecting machinery. These boards are made on the job in simple wooden frames which are removed as soon as working of the mass has been completed. They are of standard dimensions, 20 cm. wide and 4 cm. thick. Assembling proceeds making use of mortise joints provided at the time of placing the concrete. The boards are secured by means of cement pins with wooden washers or pins of galvanized iron. These can be easily taken apart and permit free expansion of concrete without endangering the strength of the whole.

Load tests made on one of the trusses at St. Jacques have shown that a uniformly distributed load of 12 tons may be safely applied and will be carried by two rafters, i. e., two boards placed after the manner of an inverted V, which constitute the essential design of the truss system.

This method of construction replaces to advantage the old wooden frame which crowded the gables and rendered repairs of the arches extremely difficult for the workmen. This new concrete frame work, being entirely independent of the masonry bulk, has done away with this difficulty.

The Nave

A series of concrete arches will hold the service platform. Simple false work, which can be moved from place to place as the work progresses, will permit an easy erection of 27 trusses, which support the main portion of the roof over the nave, which will be at a height of 19 m. or of six stories.

At the time of the present writing, seven of the trusses have been erected and the scantling placed.

This frame work will be covered by lead sheeting 3 to 4 mm. thick and 66 cm. wide, placed on scantling 10 cm. wide and spaced 10 cm.

In using thin sections of reinforced concrete, it is essential to design the frame so that each member is made to "work"; that is, to carry stress. We are thus led back to the design of the wooden truss of the fifteenth century, where each rafter was self-sufficient, transmitting no load to the other members which were to act only as braces.

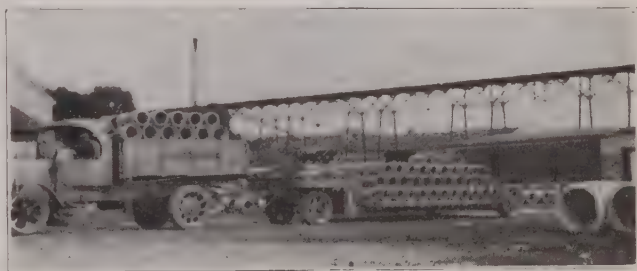
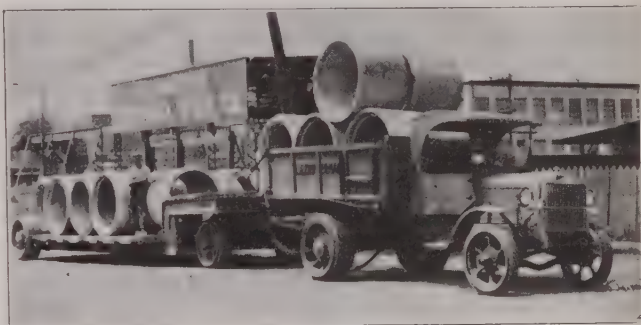
The new frame work, though executed in concrete, will weigh slightly less than the wooden one, which it has replaced. It would have been impossible to reproduce in reinforced concrete the timber work of the fifteenth century in its entirety, as it would mean that the walls would carry a load three times greater than before. In spite of the great number of units in the system adopted, the total weight of concrete shall be less than one-third of that of the wooden structure.

It is hoped that the entire program will be completed by the end of 1926. As to the completion of the transept and apse covering, and of the restoration of the tower of the Angel, these can be thought of only after completing the repairs of the arches of the choir and the southeastern pillar of the transept, which will have to be rebuilt in

its entirety, having been damaged by a shell of large caliber. This latter program represents an expenditure of from 4,000,000 to 5,000,000 francs.

When the building program is completed there will remain the restoration of the windows and of the ornamental work of the exterior. The upper galleries have lost their plaster coat, the tops of the buttresses are mostly devoid of ornament, a great deal of the sculptural work having been destroyed. Certain statues, indispensable to the general arrangement, shall be restored, such as the angels on the pinnacles, an emblem adopted by the church. We shall not mention the figures destroyed under the north tower, nor the ornamental plaster work of this tower. The restoration of these will be the work of the future. The estimate of the reconstruction work reaches a total of 134,000,000; of these five have been actually spent.

Loads Like These Bring Profit



These two loads of concrete pipe, just being sent to the job by the Consumers Supply Company, pipe manufacturers, of Milwaukee, are two of the reasons why the officials of that concern are on good terms with their banker. This plant, described in our pages last June, is now operating efficiently and is supplying pipe for almost all of the jobs around the city. The storage yard is filled with a plentiful supply of perfect well-cured pipe and tile—units that guarantee satisfaction on any project. The business is thriving and its organizers have made a real name for themselves. In fact, one of the founders is said to stand a good chance for election as the next governor of Wisconsin. Perhaps, some day, we shall see some products manufacturer who has become equally successful, aspiring to the White House itself. Who knows!

Construction Year Starts with Promise

According to statistics gathered by the Associated General Contractors of America, the volume of construction in February exactly equalled the volume of construction during the same month of 1925. January contract awards were 57 per cent greater than the awards of January of last year, while January permits were five per cent greater than the permits issued during the first month of 1925.

Reinforced Tile Home That Withstood an Earthquake

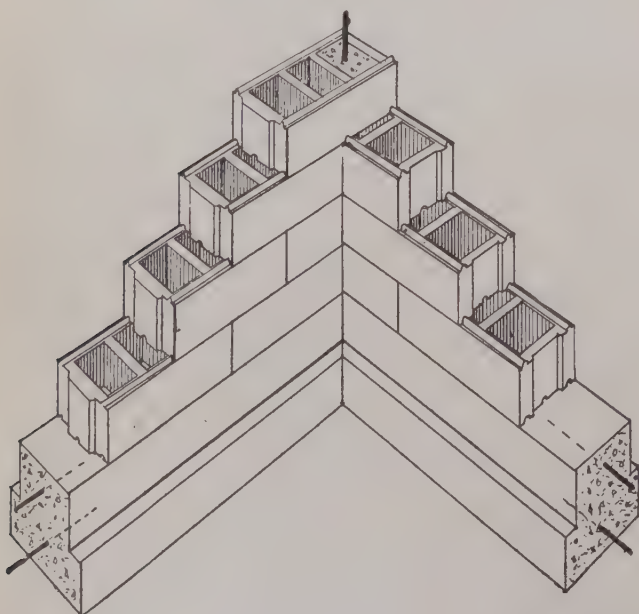
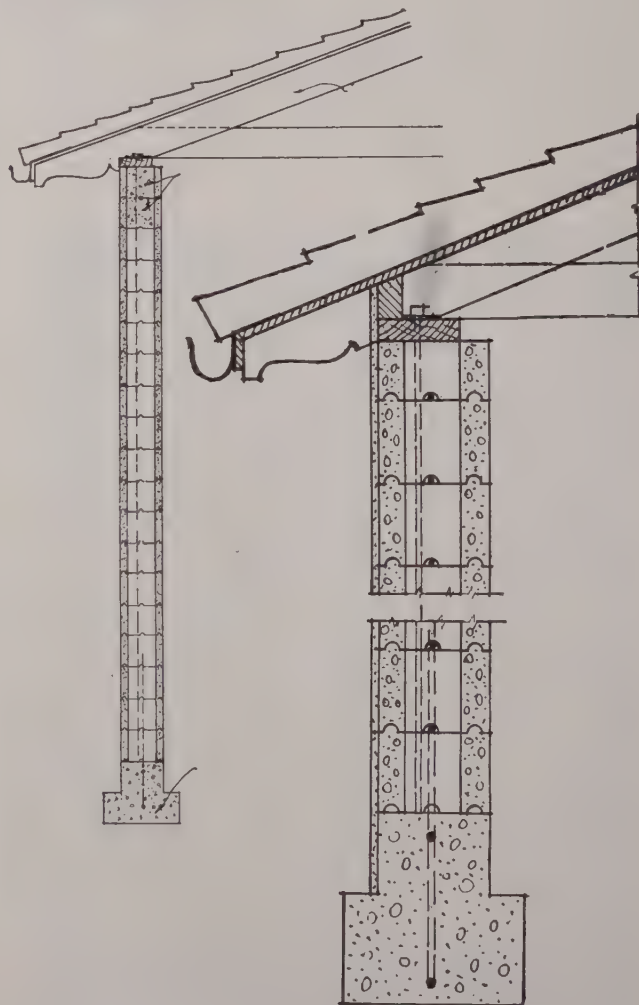
Wet Process Tile, Made by Pressure, and Grouted Into Wall That Is Reinforced, Affords a Low Cost Residential Construction That Promises to Have Real Stability, Even When Subject to Earthquake Shock, Excessive Wind Loads, Traffic Vibration, and Fire.

When the wreckage was cleared away after the Santa Barbara earthquake and the inhabitants of that community began to take stock of their losses it was gratifying to find that several types of concrete houses had come through the affair without damage. One lesson apparently learned thereby is that masonry walls should be reinforced in some way, and that roof construction should be spiked to plates that are anchored to the wall in a satisfactory manner. Another point not to be overlooked is that mortar joints should be either made as strong as the masonry units or minimized as far as possible. One such construction has already been described in our pages.

Another type of construction that is reported to have successfully passed that severe service test is that sponsored by the Mortarless Tile Machine Co., Santa Barbara, California. A wall of precast units, concrete tile, is reinforced by columns and lintels of reinforced concrete, thus providing a house that possesses structural stability at no great increase in cost. The units themselves are made on a hand press machine devised by the same concern, and are produced from a mix that is wetter than that used with the usual tamper. The unit is a tongue and groove tile designed to be laid up with but a thin grout, applied with a brush, to secure and seal the joints. This type of joint, in connection with the interlocking feature, is said to give a bond that is far stronger than that obtained by the usual block-layer's procedure. Cracks chargeable to expansion

and contraction are said to be eliminated by reason of the better bond thus secured.

The method of construction recommended by the California concern embraces a system of reinforcing which firmly binds the concrete units together as a rodded column and girder structure with tile curtain walls. Each tile should be laid to rest firmly and securely upon the other, with the tongue and groove fitting accurately. After the wall is up to the first story it is reinforced by extending steel rods from above, down into the openings within the tile, at all corners, and that vertical air space containing the bars is then filled solid with concrete. This provides reinforced concrete columns at the corners of the building, carrying their share of the dead and live loads to the foundation.



Isometric view of corner, with reinforced footing and reinforced concrete column formed in the corner air cells, tied to the footings

Two wall sections, showing reinforced concrete spandrel, detail of reinforcing, and method of anchoring the roof to the wall

The wall is dowelled to the foundation by means of bars cast into the foundation and extending at least eighteen inches up into the columns, overlapping with the column rods themselves. Similar columns may be placed at intervals in the wall according to structural requirements.

A solid concrete lintel is cast over the top of all doors, and other wall openings, and a reinforced concrete spandrel is cast at the top of the wall around the entire structure. For structures of more than one story this spandrel is cast at every ceiling level. It is tied to the columns by means of reinforcing rods according to standard practice.

The tile is provided with a groove within which to place horizontal reinforcing as desired, but since the groove to afford space for this reinforcing is in the upper face of the joint it is difficult to see how these horizontal bars could be grouted securely so as to afford good bond with the units. (Perhaps turning the units upside down when laying up the wall would make the job more easy and efficient.—Ed.)

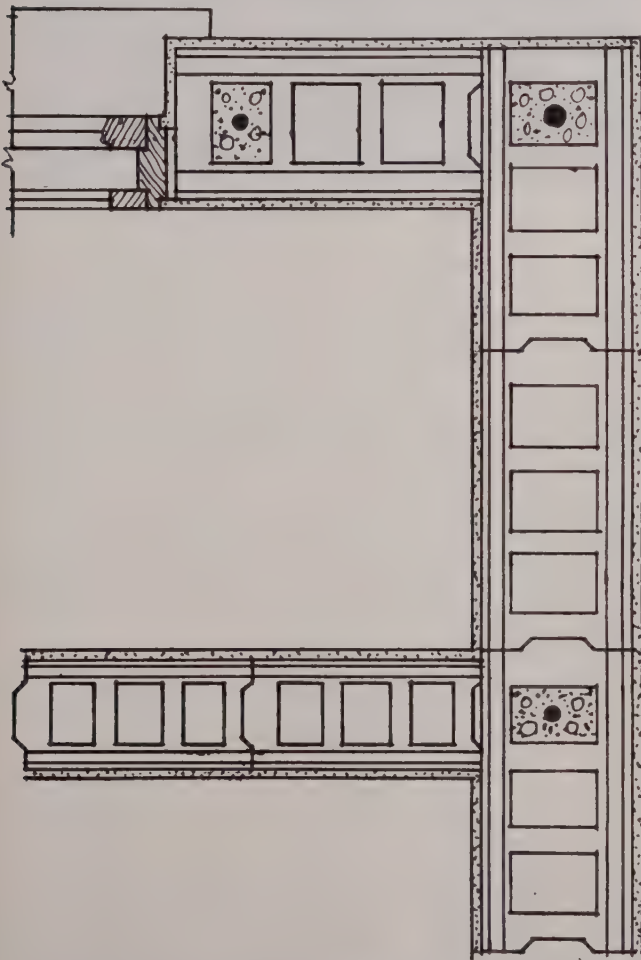
It has been the practice on some jobs to lay up the wall without buttering the joints, relying entirely upon the weight of the units and the interlocking feature to hold the wall together. The apparent fact that this has worked all right seems to show that the reinforced concrete skeleton of the structure really acts alone as a structural unit, carrying all loads. This being the case, the reader might think that more reinforcing should be used than is shown in the illustrations. It has been reported, however, that these structures withstood the severe earthquake without so much as cracking the plaster in the buildings.

So far, say the sponsors of the system, the exteriors

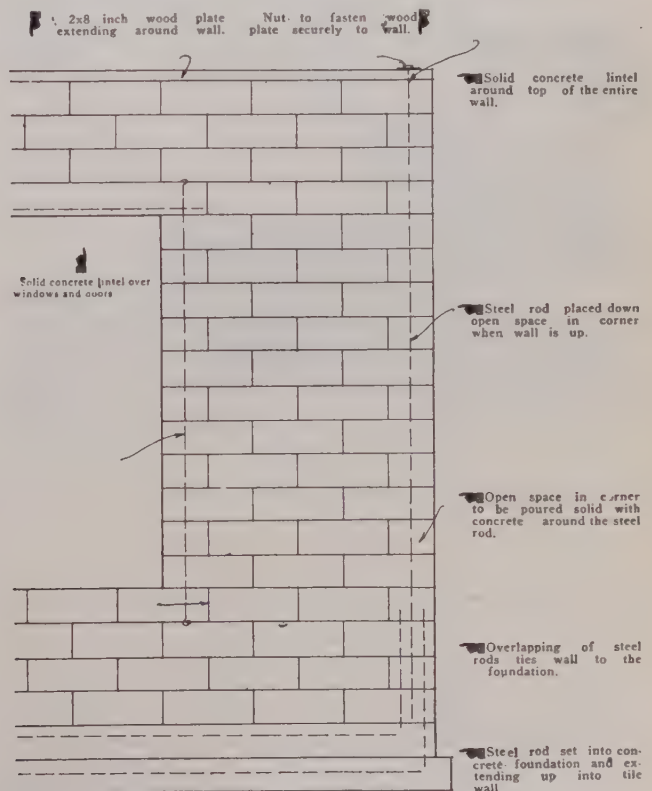
have been covered with portland cement stucco, while interior plaster has been applied directly to the inside of the walls. The air cells in the tile are said to have afforded adequate insulation for the local climate. Additional insulation could be afforded should the plaster be placed on lath, properly furred out, or should some such insulation as corkboard or the other materials of that nature now on the market be used between the tile and the plaster. The houses have been built with wood floors and wood roof construction, but there seems to be no reason why concrete floors and roofs, carried by the structural members of the building, could not be used as well.

While concrete tile itself will not usually be found entirely impervious to moisture under all conditions, in spite of the greater density that is possible with the use of more water than is used when making a tamped product, it has been found that a good stucco applied on a tile wall will be really proof against the weather. There are a number of good prepared cement stuccos on the market that will answer this purpose, or the builder may mix his own if he so desires. Even when the joints in the tile masonry are not filled with mortar or grout this stucco, two coat work applied with the trowel, will adequately seal them against the elements.

The machine itself, manufactured by the Mortarless Tile Machine Co., successors to the L. & B. Machinery Co., for the production of their concrete tile, may be of interest. This machine, which may be leased on a royalty basis for exclusive use in the community, and which is said to be capable of turning out 1000 to 1500 tile per eight hour day, is of the hand variety and is operated by two men. A wet mix, containing just enough water so as to show a slight surplus on the surface when stripped from the molds, is fed to the shaker box that feeds the machine. The head of the machine is raised and this shaker box slides over the top of the mold several times, filling it with the material. The head is then closed, and an application of force on the operating lever then



Detail plan section showing columns, partition construction, and method of setting window. Eight inch tile are used on the exterior and six inch tile for the partition or interior bearing wall



Drawing showing the placing of steel to reinforce the walls at corners, openings and at ceiling level

compressed the concrete into three-quarters of its first volume. The block is then pushed up out of the machine and is carried away on the pallet.

The cured tile, made by this machine, when the mix has been correctly designed, have been tested in a laboratory and found to have compressive strengths ranging from 1400 to 1800 pounds per square inch of net cross sectional area, with walls and webs vertical, or 4000 times its own weight.

This concern sponsors careful quality control and the obtaining of a uniform and accurately formed unit of the maximum strength. They realize that upon this quality rests the welfare of the entire industry. Perhaps that is one secret of their success in erecting stable structures in Santa Barbara.

A Good Way to Remove Old Pavement Slabs

On one road job near Barton, New York, a contractor had to first remove about a mile of old concrete road that had to be replaced by a newer and more modern one. It was found to be a mean job breaking the slab until the contractor hit upon a novel arrangement. As part of his equipment he had a Bay City skimmer scoop excavator that was to be used on the grading. The pavement, of course, was split up into slabs, each separated by the usual expansion joints. These slabs were approximately nine feet by twelve feet, to nine feet by fifteen feet, and each weighed several tons. The excavator was called into use, and was made to pick up one end of the slab, lift it to a vertical position, and then tip it over. The shock would split the concrete into pieces small enough to be picked up by the machine and loaded into trucks for disposal. The machine was then used to tear up four miles of old macadam that was found on the rest of the five mile project.



Picking up, tipping over, and breaking up the old slabs with the aid of the skimmer scoop excavator, which proved an effective process.

About a Thousand a Day and Going Strong

Here is the plant of the Marshall Lime and Cement Company, at Bridgeton, Conn., that turns out about a thousand block each working day. These manufacturers have built up a good local trade with their products, which are mostly used for the construction of garages, porches, copings, foundations, and similar work. They have recently been obtaining a price of \$20 per hundred



Photos by Ewing Galloway, New York City

for their block, which naturally produces a fair income for a plant of this type.

They appear to have a small revolving screen to grade their aggregates, which are deposited on the floor in back of the mixer. The mixer is loaded by hand, and again dumps its batches on the floor, from where the material is shoveled into the mold. A power tamper turns out the block, which are then removed to the yard for curing. A good stock of cured block is kept on hand to fill the orders as they come in.

This may not be a large or ultra-modern plant, but it is of the kind that is seen all over the country, and it is of the type that sooner or later grows into one that can turn out products at a sufficient rate to supply the need of any growing community.

New Engineer for the Gypsum Industries

Henry J. Schweim has been appointed chief engineer of the Gypsum Industries, 844 Rush Street, Chicago, Ill., to succeed the late Virgil G. Marani, who served the industry in that capacity for many years.

His engineering education was received at Armour Institute of Technology. He was associated with Mundie and Jensen, architects, with the National Fireproofing Company as chief draftsman and with the United States Gypsum Company as sales engineer, supervisor of sales, testing engineer and as district manager. During the war he was sent to New York to serve the government in securing supplies of gypsum building products and to act in engineering advisory capacities.

New Form System for Residence Walls

Hollow Reinforced Concrete Walls Formed by Means of Simple Wall Forms Developed in Los Angeles—The First Buildings Have Just Been Constructed

Probably the most recent development in concrete construction is the use of Latch lock forms for pouring hollow reinforced concrete walls. The construction is similar to that of the thermos bottle. Many materials and methods are being used to provide proper insulation, but some of these methods are ineffective, and often are a little costly.

In keeping with the ever-increasing demand for more substantial materials, more rigid construction, properly insulated homes, the Thermos Cement Building Co., Inc., of Los Angeles is said to be successfully using forms that are unique and simple, with which double monolithic walls may be poured of concrete, adequately reinforced with steel and properly insulated with a sealed, non-circulating dead air space between them.

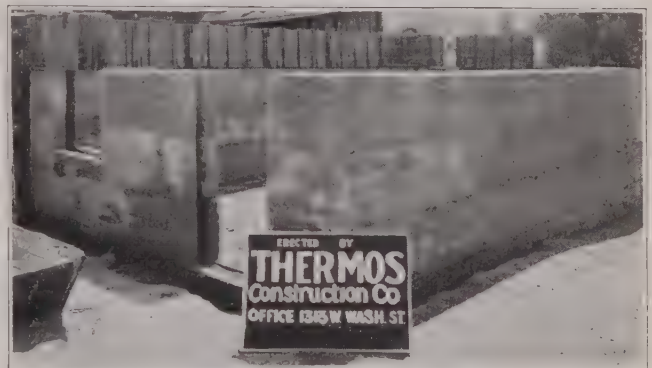
These forms appear mechanically correct in theory, and

Key to drawing showing details of the form system

1. Core section of forms.
2. Exterior section of forms.
3. Latch lock holding core walls out to place.
4. Latches locking exterior forms to core sections.
5. Latches locking exterior forms end to end.
6. Core collapsing levers.
7. Wing nut latches holding exterior sections to core.
8. Opening in exterior form for wing nut latch.
9. Latch lock releasing lever.
10. Cover for dead air space.
11. Plate bolted to top of finished walls.
12. Bolts embedded in concrete retaining roof or ceiling joists plate.
13. Manner of placing ceiling joists.
14. Roof section showing rafters.
15. Section of window or door frames.
16. Ends of floor joists embedded in concrete.
17. Dead air space.
18. Reinforcing steel over openings.
19. Horizontal and vertical reinforcing steel.



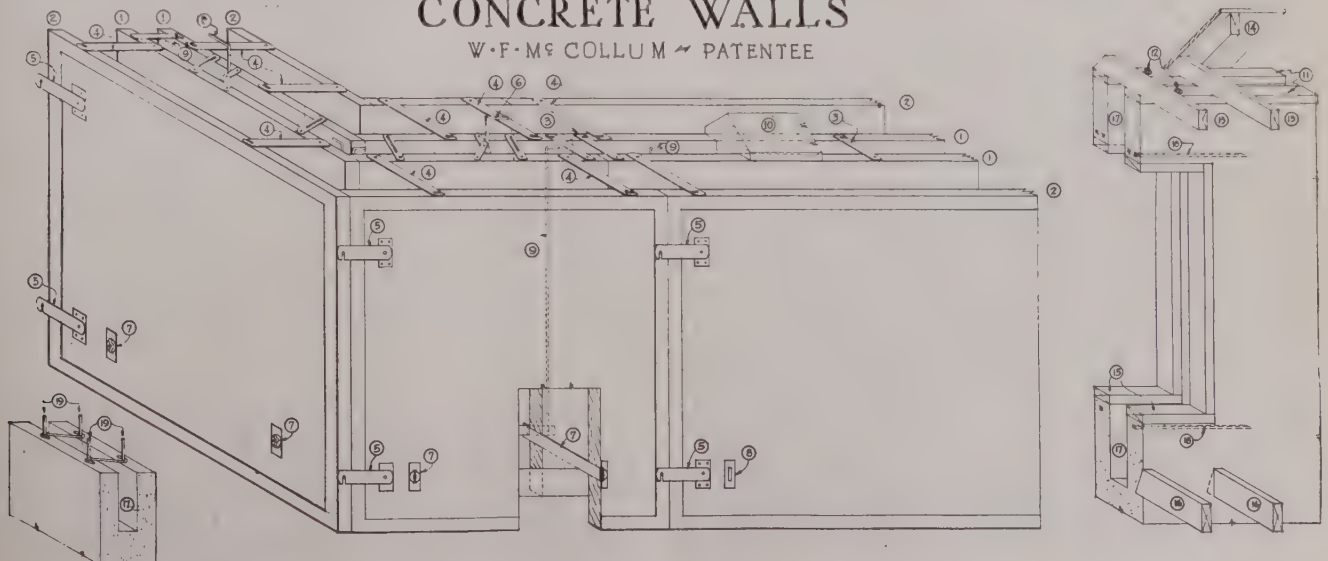
A small house and garden wall built by this new form system



The forms in use, running up the wall for a small building. This concrete will later be covered with stucco

LATCH LOCK FORMS FOR POURING HOLLOW RE-ENFORCED CONCRETE WALLS

W·F·M & COLLUM PATENTEE



proven in use, practical in operation, in that they are readily assembled and easily stripped. The handling of concrete with these forms is greatly expedited, thereby reducing the overhead of construction, and are demonstrating that hollow reinforced concrete construction is possible for the small home.

These forms and the system may be called "latch locking" in that the simplest and most positive means of locking them together is used.

Once an adequate foundation is poured, these forms are set in place, plumbed and straight the entire circumference of the structure. By means of a good concrete mixer and sufficient labor, one complete course, 24 inches high per day, is poured. This consists of two 4-inch solid concrete walls with a 4-inch dead air space intervening, reinforced horizontally and vertically.

Another noteworthy feature of these forms is the fact that all interior partitions are poured by utilizing the outside sections only.

These forms were patented by W. F. McCollum, 1313 West Washington Street, Los Angeles, Calif.

British Issue New Standard Portland Cement Specification

By A. C. BLACKALL

London, England

The British Engineering Standards Association, which corresponds to the U. S. Bureau of Standards, has just published a new issue of the British standard specification for Portland cement, which was last revised in 1920.

In the course of the work of revision a more precise method was sought than that previously adopted for the determination of the consistency of the neat cement paste for the tensile and setting time tests. Very extensive investigations were carried out, but no method was found which could be considered unquestionably more reliable, and the directions of the previous editions of the specification have therefore of necessity been retained.

The principal alterations embodied in the 1925 edition are: (1) A summary of the tests is given at the beginning of the specification. (2) Provision has been made for testing in hot countries at temperatures up to 95 degrees or below 58 degrees F. special arrangements have to be made between the vendor and the purchaser unless the ranges given in the specification can be artificially produced. (3) The cement is now required to be more finely ground, the permissible residue on a 180 by 180 sieve being 10 per cent, instead of 14 per cent. Tolerances are laid down for the number and size of openings in sieves both for cement and for sand. The minimum size of the sieving area is now specified to be 50 square inches and the minimum depth of the sieve to be $2\frac{3}{4}$ inches. (4) The minimum figure for the hydraulic modulus has been raised to 2.90 and the maximum for magnesia is now 4 per cent. (5) The minimum tensile breaking strength of neat cement after seven days has been increased to 600 lbs. per square inch, and that of cement and sand after 7 days to 325 lbs. per square inch. The twenty-eight days' test on neat cement has been eliminated. (6) The amount of water for gauging cement and sand briquettes is now to be ascertained by means of a formula based upon the amount needed to produce the plastic mixture required in the tensile test for neat cement. (7) The standard sand from Leighton Buzzard is required to be of the white variety, and its loss in weight on extraction with hot hydrochloric acid is specified not to exceed 0.25 per cent. (8) The initial setting time of normal cement is not to be less than 30 minutes, and the initial setting time of quick-setting not less than five minutes.

Footbridge Built and in Use in 48 Hours

From Zement by E. Lee Heidenreich.

The accompanying illustration is that of a footbridge of reinforced concrete designed and built by Cristiani & Nielsen, Danish contractors, over the weir of a dam in Brazil.

The span is 82 ft., and the width 2 ft. 6 in., and the entire construction was executed with Lafarge aluminous cement.

Forty-eight hours after pouring the concrete the structure was stripped of the forms and immediately put in use.

Both in France and England Lafarge aluminous cement is being used for street repairs, wherever the traffic requires that the street must be used within 48 hours, and where formerly at least 14 days were required for making repairs. 1:3 test pieces of the concrete used, showed a strength of 5100 lbs. per sq. in. compression in 1 day and 8100 lbs. per sq. in. in 7 days, while regular Portland cement concrete in the same periods showed 278 lbs. and 2800 lbs., respectively.



Concrete bridge used 48 hours after pouring.

Colored Concrete Being Tried on British Homes

A very interesting British development is the decision to use concrete that has been colored on the new housing schemes that have been inaugurated by the London County Council. In addition, a bridge is now under construction by the Cumberland County Council in which the concrete has been colored pink. This bridge, which is nearing completion, has been so colored in order that it may harmonize with a house near by. This house is built of pink sandstone, and in the construction of the bridge a percentage of coloring made up of pink Shap granite and Bowscar red sand has been used for the concrete aggregate. Special tests had to be made in order to ascertain whether the addition of this coloring matter affected the strength of the concrete. The most successful experiments near London in using color in order to provide attractiveness to housing schemes may be seen at Welwyn Garden City.

Johns Hopkins University and the U. S. Bureau of Public Roads are collaborating on a series of tests to establish, if possible, a co-efficient of proportionality between static modulus of rupture of concrete beams and impact modulus of rupture. Tests, too, are being conducted for modulus of elasticity and crushing strength of control cylinders.

Earthquake Proof Construction

By H. M. HADLEY

Stiff-Frame Type of Building with Trussing or Reinforced Concrete Exterior and Interior Walls Recommended to Withstand Earthquake Shocks—Reinforced Concrete Wall Alone Recommended Because It is Only Wall in Which It Is Practical to Introduce Reinforcement to Resist Tensile Stresses That Occur Equally and Simultaneously with the Compressive

The prerequisite to any problem of engineering design is a knowledge of loads and forces involved, and to this rule the problem of rendering buildings and other structures earthquake proof is no exception. Before any beginning can be made on the problem something must be known of the earthquake itself, what it is and what is to be expected at times of earthquake occurrence.

Briefly an earthquake consists of sudden and always unexpected movements in what all our normal experience leads us to regard as the fixed immovable earth—the terra firma. These movements may be so slight as to be almost imperceptible; again they may be so violent as to wreck all but the strongest structures. They may be brief; they may be prolonged. They may occur anywhere at any hour; they may not occur for decades or even centuries. It is doubtful if with present knowledge they can be predicted in any save the most general way. Certain zones and districts are known to be more subject to earthquakes than others, and from a study of past performances and correlated phenomena, some foreknowledge may be obtained, but from the very character of the earthquake, precision is scarcely to be hoped for.

Horizontal Movements

The earthquake movements are both vertical and horizontal, the horizontal being in general 6 to 10 times greater than the vertical. Since all structures are designed for vertical loads and presumably with an ample factor of reserve strength, the stresses induced by the vertical component of earthquake motion may be ignored. No ordinary, wellbuilt structure with good firm foundations will sustain any serious damage from such vertical movement.

But the horizontal component of the earth movements may in no wise be ignored. Depending on the magnitude of the horizontal movements and the time in which they occur forces of varying magnitude are developed and in cases of severe earthquake these horizontal forces will destroy or severely damage all structures lacking in resistance to them. At any locality this horizontal earthquake movement may occur in any direction, consequently it is necessary to provide resistance against earthquake forces acting in any direction. A severe earthquake may easily develop a horizontal force applied to the base of the structures equal to 1/10 or more of their combined live and dead loads. However, if actual designed provision, employing the usual factors of safety, had been made and executed against horizontal forces of 1/15 or even 1/20 of the total loads, it can safely be said that the great majority of the damage done by the Santa Barbara



Two steel-framed buildings in Japan. The seven-story building of Katakura & Co., Tokio, Japan, had concrete walls and sustained no earthquake damage. The one-story gas purifier shed of the Yokohama Gas Co. collapsed on account of lack of adequate bracing



From a paper presented at the 22nd Annual Convention of the American Concrete Institute, Chicago, Ill., Feb. 23 to 26, 1926.



Two small brick school buildings at Santa Barbara. These buildings are of the same size and stood on adjacent corners of the same block. Observe difference in wall construction. The small building on the right suffered no damage whatsoever

and Tokyo-Yokohama earthquakes would not have occurred.

Requirements of Design

When foundations and column bases are suddenly moved sideways by the irresistible movement of the earth, there must be strength in the vertical members of the structure above to do one of two things; either to bend and deform with adequate resistance to the stresses produced by such bending and column eccentricities, or to carry the structure bodily as a block or unit with the foundations and without major deformations. Economy and the character of the structure will largely determine the type of resistance to be provided. It is pertinent to call attention to the fact that with the possible exception of metal lath and plaster, none of the finishing material employed in building of any consequence are flexible. The essential incongruity between a flexible structural frame and these inflexible things which the structural frame must sustain has resulted in many a sorry spectacle—and the loss of millions of dollars.

For the great majority of buildings and structures it

will be found that the stiff frame type is the most practical, adaptable and economical for the resistance of earthquakes. Once it is decided that provision is to be made against horizontal earthquake forces the magnitude of these forces must be assumed as some fraction of the vertical loads. Considering the fortunate infrequency of earthquakes at any particular locality, reliance may well be placed on the reserve strength provided by the usual working stresses used for normal loads. Consequently, with a safety factor of 3, $1/15$ may be recommended as the coefficient giving an ultimate resistance to an earthquake whose dynamic effect is that of a force $1/5$ of the total weight. Earthquakes more severe than this are very rare. Having selected some coefficient—say $1/15$ —then in each story design must be made to resist horizontal forces equal to $1/15$ of all vertical loads in columns and walls in that story. These forces are analogous to wind pressure and the design against them is similar to the design against wind loads. They measure the shearing force in each story and the tendency of the portion of the building below to move horizontally with respect to the portion of the building above.

Concrete Wall Best

Resistance to these forces can be obtained in the stiff-frame type of building either by trussing or by a sufficient



Two wooden buildings at Santa Barbara. On the right, the gymnasium at the Teachers' College possessed well-designed, well-braced wood frames. The stuccoed exterior was not even cracked. Left, a two-story residence that had no bracing on its underpinning



Two concrete schools at Santa Barbara, Calif. The Santa Barbara High School had well designed concrete wall construction and

amount of exterior and interior reinforced concrete wall construction. Such wall sections are figured as beams, for bending, shear, bond, etc. The reinforced concrete wall is alone recommended simply because it is the only wall in which it is practical to introduce reinforcement to resist the tensile stresses that occur equally and simultaneously with the compressive. With either diagonal bracing or structural wall, a good distribution with respect to the plan of the building is important: It should not all be localized at one point. The corners of the buildings constitute especially effective points for such sections and there is the further advantage that the sacrifice of light is there a minimum. Stair and elevator enclosing walls may also well be used.

When adequate structural resistance has been provided, the remainder of the wall and partition construction may be of any of the common masonry types, or of glass, or may be left open to the air. But full skeleton construction, so common in America practices of today is certainly financially, and quite possibly structurally, unsafe at times of severe earthquakes. With the exception of certain steel-framed mill buildings covered with galvanized iron, neither at Santa Barbara nor in Japan did the speaker see skeleton framed buildings of any material that escaped damage. Hope is a poor material for bracing.

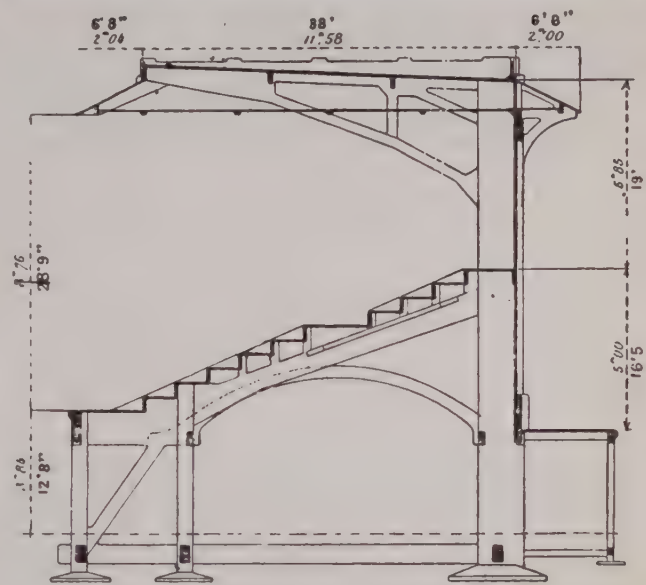
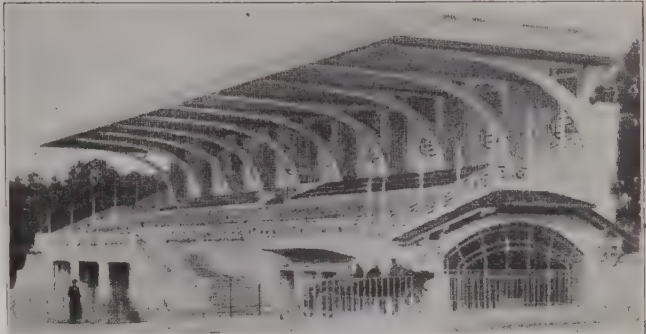
Whatever the materials of construction, every effort should be made in the design to tie and interconnect as fully, and adequately as possible all structural parts, and to firmly attach to the structural frame all filler and decorative material used for the complete structure.

The accompanying views are representative of successful and unsuccessful construction with various materials.

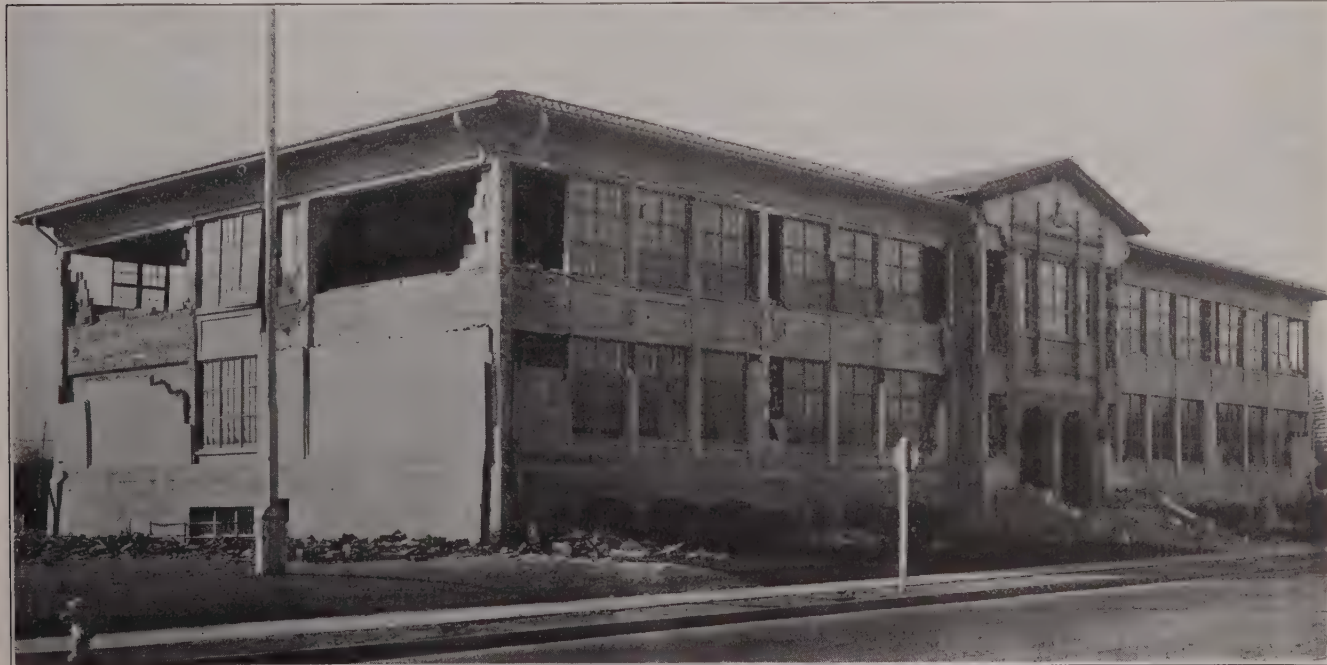
Concrete Used in Race Course Stand Near Paris

To provide a clear view of the track, eliminating the necessary obstructions caused by brick construction, reinforced concrete has been used in the erection of a race course stand at "Bois de Vincennes" near Paris, with 1,500 seating capacity. Cantilevers, spaced at 21 ft. 4 in. centers, and supporting a concrete roof slab 23⁄8 in. thick,

allow a roof overhang of 45 ft. Dimensions of the stand are 43 ft. long by 49 ft. wide. One hundred twenty lbs. per square foot was allowed for live load on all parts publicly used, with a 12 lb. load assumed for possible snow on the roof, and 30 lbs. per square foot for wind pressure on vertical surfaces.



Photograph and vertical section of the grandstand at the Paris race course



sustained no damage. The Wilson School was a skeleton structure with clay tile filler walls and was seriously damaged

The Big Things of the Year

The Recent Convention of The American Concrete Institute Marked New Advances of Interest to the Concretor—The First Fruits of Scientific Investigation—Getting Down to Facts and Common Sense on Cement

It was not entirely the things provided for by the program, but to a large extent the things revealed upon the prompting of the program that made the recent annual convention of the American Concrete Institute an affair to be remembered. Looking back upon the proceedings of a month ago—proceedings fraught with significant meaning—one obtains a clear picture of the great strides that have been taken by the industry in the past twenty-odd years. It may possibly be said that the concrete construction industry is just entering a new stage of endeavor—a stage where the concretor is able to take advantage of precise theoretical knowledge, and wedding it to his native common sense, he is able to produce concrete structures that are better, more efficient, and more economical than ever before. Research has passed from the stage of unrelated and unguided minor investigations and has firmly entrenched itself on a higher plane of unified effort and immediate and ultimate practicability. There is less of the attitude of taking concrete as a great mystery and more of the attitude of taking advantage of its known properties to the fullest possible extent. Since the contractor could not be easily persuaded to come to the laboratory, the laboratory has been brought to the contractor. The man of science and the man on the job are standing in the same mud,—greatly to the improvement of both and to the benefit of the work. Science, in coming down to earth, is progressing all the better for the firmer footing that it has gained.

But that general observation was not the only one that obtruded itself upon the consciousness of the spectator. Several papers and question box answers revealed, by means of themselves and subsequent discussion, things that are of outstanding importance.

Take, for instance, the matter of cement. For years the builder has been told that portland cement was portland cement, and that the material was so thoroughly standardized that all would act the same, no matter from where it came. For years he has wondered why one brand seemed to give better results on his work than did other brands, and he usually settled upon one, or two, or three brands from the local market that suited him the best. Yet, so insistent were the claims of the cement manufacturers that he hesitated, at times, to admit that he was right.

Yet, at the recent convention, the matter of properties of cement appeared to be of real importance. The hearer was given the impression not only that the properties of all cements were different to some extent, but that absolute uniformity was impossible with such widely varying raw materials. The contractor is beginning to select his cements for the work in hand. When weather is cold, then high early strengths are to be sought. When the weather is hot, then other qualities are to be desired. Since cements are admittedly not strictly uniform as to tensile strength nor as to initial or final set, then it is to be expected that the concretor will compare the cements on the market and standardize on certain brands for specific uses. This is a condition that cannot long be ignored by the manufacturer of cement, nor will it be.

Yet, while present cements lack uniformity greater than

the uniformity of modern mix control, the old standards served well in the recent period where concrete itself could not be produced with equal accuracy. Special cements and selection of cements, while being needed for the experienced contractor, are not needed for the man who has not yet learned to use the standard variety.

Then there is the method, described in detail elsewhere in this issue, whereby strength of concrete can be governed by the proportion of cement and water, while workability can be obtained through adjustment of the aggregate proportions. By that method stronger concrete may be gained and costs reduced at the same time. It removes, at last, the great bone of contention between engineer and contractor. That one development is the practical culmination of years of scientific investigation. The water-cement ratio theory will stand as truth until the undisputable results can be explained logically in some better fashion.

Then came another great thought, a conclusion that was announced some months ago in the pages of this journal. Concrete, like the human frame, apparently can be healed after fracture, with the "scar tissue" forming a joint still stronger than the surrounding material. Observed under radically different circumstances by at least three independent investigators, the great announcement carried considerable weight. This phenomenon may be taken advantage of, as soon as the conditions are better known, greatly to the benefit of the industry. The study of it may lead the investigators into knowledge that may even solve other questions yet perplexing the best minds of the industry.

Then the great interior heat generated in the center of mass concrete, as revealed in another paper, aroused speculation that may in turn lead to important knowledge. Cracking, the pest of the industry, may be eliminated as a result of a study of that factor, or as a result of studies reported by a past president of the Institute in discussing the extensibility of concrete. Cracking is being studied on every hand, but until it can be eliminated it may be made of little importance by the use of a rough texture or by means of grinding off the crazed surface. The retempering of concrete, long condemned by every authority, now stands approved by the leading investigator of the field, for retempering has been found to have its uses when properly done.

Another outstanding idea was that water should be added to concrete for workability and removed from the placed concrete to afford strength. The same architect who presented that thought, declared that the exterior architectural treatment of a structure should be considered entirely apart from the structural frame. The acceptance of the principle of an architectural shell would suggest the use of greater beauty of form, texture and color in the design and construction of our buildings.

Then came a great prophesy for the future, a looking forward to the day when our railroads will run at high speed on beds of solid concrete—steel-ribbed highways of rapid transit. Too, a day when earthquake and fire will wreck our cities no more—a day when concrete will be the one material of construction—a day toward which all this work is leading. That is the convention in retrospect.

Concrete Masonry in Florida

Interesting Sidelights on the Wide Use of Concrete Units and Stucco in Building Concrete Homes in That State—Conditions Call for Early Delivery of Block—Curing in the Wall—The Coral Gables Structures

Concrete masonry is having a remarkable and an intensely interesting development in southern Florida.

The volume of concrete masonry is large at present and rapidly increasing. Aggregates available for the manufacture of concrete building units are scarce and unique in their characteristics. Manufacturing practice and methods of using concrete masonry materials on the job vary to accommodate unusual local conditions. Climate, architectural preference, special types and kinds of building required and an acute shortage of construction materials are influential factors.

Much Good Construction

There has been considerable condemnation of building standards prevailing in southern Florida and quite a general feeling that about 90 per cent of the emphasis has been placed on decoration and 10 per cent on structural quality. This is not always or even usually the case. While it must be admitted that there is much new construction which is inferior and even some which is scarcely more substantial than stage scenery, the ratio of good to poor is probably as high if not considerably higher than has prevailed in equally rapid development and settlement elsewhere.

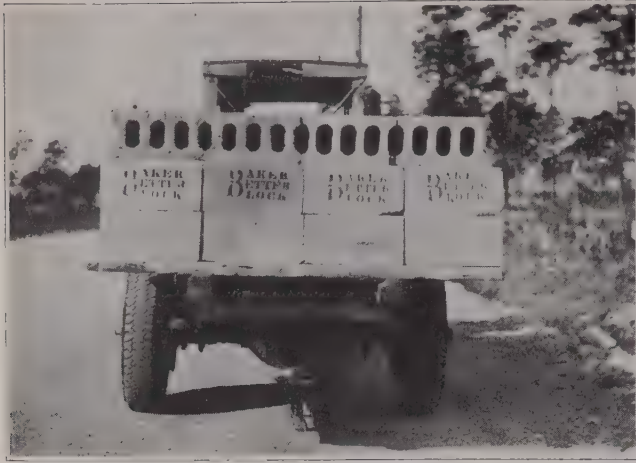


A quaint little Spanish place with an even quainter little garage, all of concrete masonry with tinted stucco.

It is no secret nor does any mystery attach to the fact that concrete masonry construction in southern Florida is, almost without exception, above the level of expectation, while several of the less substantial types frequently appear at their worst. This condition is due to a combina-



Progress view of Coral Gables Congregational Church, built of concrete masonry. The campanile has a reinforced concrete frame with curtain walls of concrete masonry.



Motoring in any direction from the center of Miami, one soon overtakes trucks delivering block. This view was taken last January.

tion of prevailing circumstances which accentuate or bring into play many of the favorable characteristics of concrete masonry, while they often serve to show up chronic weaknesses of light framed wooden construction, whether exposed or hidden behind some kind of a veneer.

Concrete block and building tile factories in southern Florida must use as coarse aggregate Ojus or other soft lime rock quarried in that region, or bring in graded gravel from Montgomery, Ala., or other distant points. Available fine aggregate consists of fine beach sand or "artificial" sand produced by crushing natural rock. The distant material mentioned is not only very costly because of the freight charges, but the long southbound haul is slow and subject to embargo. As a consequence, local sand and stone, although requiring more cement to give equal strengths, are generally found most economical and have been used almost exclusively.



Concrete masonry residence under construction in a Miami suburb, showing easy adaptability of this material to the forming of arches.



A small house—but quality is as good as in the largest. Note the lintels and arches cast in place. The chimney will be a large decorative Spanish affair.

Unusual Aggregates

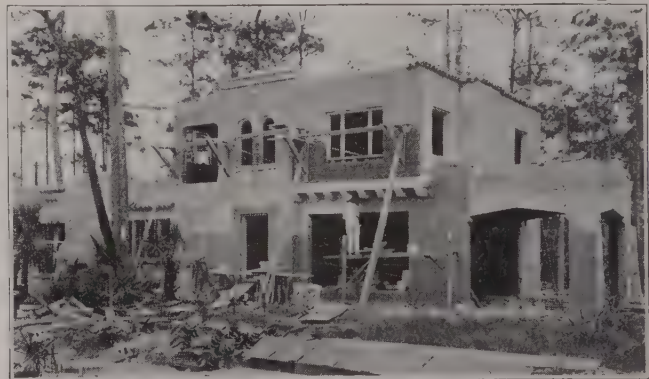
Such studies as have been made of the native rock of southern Florida seem to indicate that its suitability as an aggregate for block and building tile manufacture probably has been underrated. Although quite soft when quarried this rock hardens rapidly on exposure to the air. Furthermore, it has a great deal of fluxing value, greatly increasing the workability of the mix. It produces a mix which is smooth rather than harsh; whatever the crusher run of this rock seems to lack by carrying excessive fine material is apparently made up by a workability which requires less water and improves strength characteristics.

Florida weather conditions are remarkably favorable to the hardening of concrete. Grade level is only a few feet above that of the surrounding ocean and gulf. A large proportion of the nominal area is covered with lakes, rivers; streams, canals and ponds. The rainfall is plentiful and well distributed over the greater part of the year. The result is an atmosphere which is always very humid, frequently approaching the saturation point. Under climatic conditions such as prevail in southern Florida throughout almost the entire year, concrete is very nearly self-curing; in fact, the curing process continues its good influence indefinitely, quite in contrast with circumstances where good curing continues only a few days.

Block Delivered Green

As a result of the strong demand for concrete block and tile in Florida the practice of sending these materials out onto jobs in a relatively green condition has gradually come into use. It now prevails to a considerable extent throughout the rapid building season which includes about ten months out of the year. In some places buyers have fairly stormed the factories, demanding block, cash and carry, no questions asked. While most students of block and tile manufacture feel justified in denouncing unqualifiedly the practice of shipping "green" material, experience has indicated that with careful handling to prevent breakage in moving to the job, it is feasible under local conditions to lay up the block and tile at early ages, depending on further hardening to take place in the wall. Since, for example, standard quality blocks testing 700 pounds per square inch of gross area provide a factor of safety of 30 to 60 as ordinarily used, it is apparent that no structural difficulties are likely to result by using block which, soon after manufacture, might test 500 pounds to the square inch.

Not only has the use of rather green material proven feasible structurally, but the ease of cutting and handling partially hardened blocks made with fine aggregate has had a favorable effect on the masons who lay them. Moreover, block laid under these conditions bond exceedingly well with the mortar and stucco. It is undoubtedly true



Reinforced concrete beams and lintels are generously used in these Spanish homes.

that many of the concrete units used in southern Florida, if tested according to standard practice, when 28 days old, would exceed usual specification requirements. Concrete products manufacturers in the vicinity of Miami feel that they are forced by strong demand requiring quick deliveries to use sufficient cement to give convenient handling strength in two or three days, compression strength tests at 28 days being almost completely lost sight of.

Block Cure on Job

The unusually high humidity affords good curing for concrete placed on the job as well as for that which is produced in the block and tile factories. Stucco is also greatly benefited. The moist atmosphere protects it against drying out during the early hardening period and helps greatly in obtaining even, unblotched colors. Better curing due to favorable climatic conditions probably accounts for the successful use of more vivid tones without irregularity or fading. Stucco work in southern Florida is relatively free from crazing notwithstanding the common use of fine aggregate and surface trowelling methods which are generally known to encourage this difficulty. This condition furnishes further proof that curing methods have a lot to do with crazing. Likewise, efflorescence appears to give little trouble although the bright and vivid colorings so frequently used would afford backgrounds against which any "bloom" which might come out could be seen readily.

Florida is giving the rest of the country a practical demonstration of the value of good curing. Notwithstanding the deficiency in the quality of aggregates and the difficulties in maintaining high construction standards in the face of unusual building demands, concrete masonry construction in southern Florida is probably of better quality than could be expected under similar conditions in other climates. In fact, the quality of concrete masonry is particularly outstanding when other types are brought into comparison.

Concrete masonry construction is going to prove one of Florida's permanent assets. One may see many "homes" erected with wood studding 16 inches, 20 inches or even 24 inches apart, sparsely braced, sheeted with a building paper carrying a makeshift metal fabric on which is smeared a skimpy covering of stucco. Such construction is bound to be short lived. Some of the most important fundamentals in the preparation of the base for stucco

are violated to an extent which will, in all probability, lead to early grief.

Severe Climatic Conditions

Climatic conditions which help so materially in the curing of concrete make extreme care necessary to produce buildings that will remain dry under all conditions. Even with the ground saturated and water covering the surface, capillary action must not lift moisture to the walls above ground. Driving rains must not penetrate walls or find means of ingress around openings. Good thermal insulation is desirable in order to moderate temperature changes as much as possible. The high humidity makes even a slight drop in temperature seem colder or a slight rise more oppressive than in relatively dry atmospheres. Dry concrete walls seem to store up the heat of the day which is radiated in the cool of the evening. Concrete masonry has performed remarkably under the exacting range of Florida conditions, providing ample protection against both heat and moisture.

A short description of Coral Gables, the newly developed Miami suburb, will serve to give the reader some idea of what is being accomplished with concrete masonry in that vicinity. Other suburbs, such as Hialeah, Hollywood and Coconut Grove, as well as the city of Miami itself, are big users of concrete building units, although Coral Gables is built almost exclusively of concrete masonry—over 99 per cent of its buildings having concrete block



Fitting of fractional block is easily accomplished.



San Sebastian Apartments, Coral Gables, under construction—Reinforced concrete structural frame is used for the main portions of the building, while concrete block are employed for partition and curtain walls throughout.

walls covered with textured and tinted portland cement stucco.

Coral Gables Described

Coral Gables is probably the largest and finest suburban development project ever undertaken. It occupies over 10,000 acres of land, covering more than 16 square miles. The architecture of Coral Gables is what has come to be known as Mediterranean—an attractive combination of the Spanish, the Moorish and the Byzantine with a touch of the Italian thrown in. One architectural theme is followed throughout.

Mr. George E. Merrick, who conceived Coral Gables, and his architect, Denman Fisk, undertook to transplant the beauty and charm of these old world places, which is so largely dependent upon the mellow tones and pleasing textures of the universally plastered exteriors. They found that the masonry houses along the old world Riviera were not built of thick, heavy masonry by chance, any more than were the adobe houses of the hot Mexican plateaus. They observed that these heavy walls serve a dual purpose—protection against temperature extremes and the provision of a substantial, non-moving base for artistic plastered exteriors. The practice of applying stucco over a wood frame is not and never was followed in Europe.

There are now completed some 2,000 beautiful houses, two churches, a country club, five hotels, three schools, many stores and a number of commercial buildings. A new section is now building where apartments are being erected. One portion of the town contains modest cottages which almost any worker may purchase with a small first payment. More than ten million concrete block, worth over \$2,500,000 have gone into residences alone. No estimate could be made of the quantities used in the various public, religious, recreational, educational and commercial buildings, but there are individual structures in the community which used approximately 50,000 standard 8 x 8 x 16 block.

Good Construction

Although the buildings at Coral Gables have been designed by a number of well known architects, construction details and methods are prescribed by the supervising architect. These bear close resemblance to the methods advocated in "Manual of Concrete Masonry Construction" by the Portland Cement Association, with which readers of Concrete are quite generally familiar. Except in the larger buildings, 8-inch bearing walls are used. Sills and lintels are all reinforced and precast. Where concrete masonry is used for partition and curtain walls, the 8-inch width unit is used entirely. The mortar used for the most part is a combined cement and lime mixture, 1 part cement, 1 part lime and 6 parts beach sand.

While a variety of colors and textures have been used in the stucco surfaces, beautiful buff and pink tones prevail. They harmonize effectively with the bright green vegetation, vivid flower colorings and the pinks, reds and grays of the roofs. The stucco textures are ingeniously broken up to give soft, irregular shadows. Two tone effects are employed to a considerable extent. In some cases the base color has been followed by one that is lighter in shade and applied so that the under coat appears occasionally. Sometimes a third color is blended over the two.

Many of the more vivid effects are obtained by staining the color on the partially cured surfaces. A surprising variety of beautiful effects have been obtained and experience with them seems to insure a reasonable degree of permanency. All of these stains appear much improved with the slight mellowing which takes place over a period of

two or three years. Coral rock is veneered on the concrete masonry occasionally for the purpose of producing irregular outcroppings of this material through the stucco. These are very effective in giving the buildings a soft weathered appearance.

Concrete Floors Common

Floors throughout Coral Gables are almost entirely of structural concrete. Living room floors are covered with hard wood or art floor tile. In service rooms colored mortar or enameled surfaces produce pleasing effects and have been found very serviceable. Porticos, patios and porch floors are of tile laid after the Dutch method. Roofs are of wood framed construction covered with tile, a large proportion of which was taken off of old Spanish buildings in Cuba and Spain. Some of the more recent buildings in the vicinity are roofed with concrete tile.

The architectural types being developed in Miami and vicinity, the success of which depends so largely on the efficiency of concrete masonry, are beginning to have great influence on the architecture and building habits of the south. There is so much to them that is obviously good that their influence will probably be detected before long even up here in the conservative communities of the north, where we are just beginning to learn that textured and tinted portland cement stucco on a concrete masonry base offers prospect of pleasant relief from sombre brick and paint-bereft frame surfaces with which so many of our cities are infested.

Cincrete Producers Favor and Plan Big Merger

In an interview on March 24, Charles R. Flint, of Flint & Co., Inc., and George L. Benbow, of Rufus Waples & Co., both of New York City, stated to a representative of CONCRETE that between 65 and 70 per cent of the licensed manufacturers of cinder concrete block have indicated their interest in a proposed merger of cinder concrete block producers. These producers have submitted financial statements of their respective companies to the officials organizing the merger. These financial statements are to serve as a basis for a financial plan to be outlined for the formation of the proposed organization.

The proposed consolidation will be a corporation, temporarily known as The National Concrete Products Corporation, that will manufacture Cincrete units in various cities and take care of sales and distribution on a national basis. The current patents, with the exception of those owned by the Cadwell interests, have been purchased by the new Building Units Patent Corporation, a corporation to be owned by the proposed manufacturing organization. Ten thousand no par value shares of stock in the consolidated company will be used in strengthening existing patents and in purchasing new ones, not only for cinder concrete block, but for machinery, apparatus, formulas and methods which will materially reduce the cost of production.

The directorate of the patent corporation includes Jos. A. Beck, Geo. L. Benbow, John W. F. Bennett, Sigurd Bo, Thomas J. Byrne, P. D. Case, Einar Christensen, Drury N. Cooper, Alfred Owen Crozier, Chas. R. Flint, Paul M. Fogel, L. A. Goodwin, Wade Millis, Chas. L. Pierce, and Francis J. Straub.

The brick men in the east have just begun to wake up to the fact that they were no longer living in Old Testament days and that they were losing profits by turning out a hand-made sun-dried product. The back-yard products manufacturer can profit by their example.

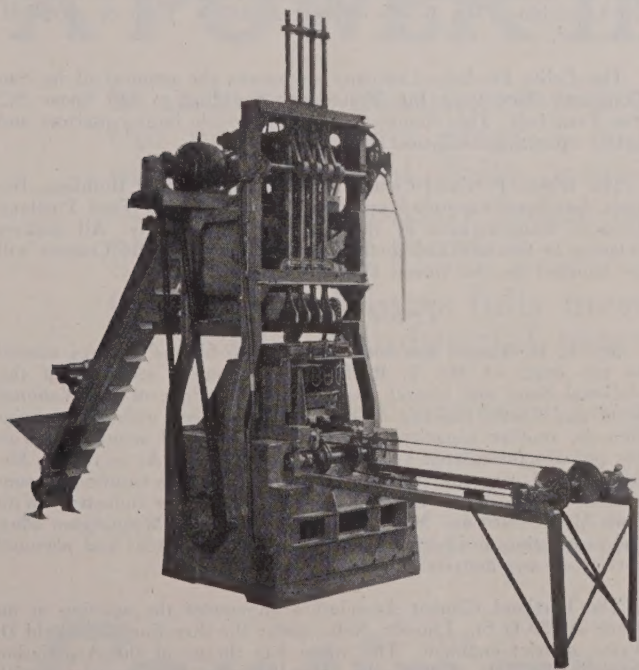
New Equipment

The New Abram Automatic Down-Face Stripper

At last it has been done. An automatic down-face stripper has been perfected that will permit the manufacture of plain or face block on the same machine and at an equal rate of production. Now it will be an easy matter to make face block with the wet mix ordinarily used in making plain block, and thus take advantage of better curing and make possible the production of a better grade of ornamental block—at a lower price. It has long been a recognized fact that the stripping principle is well adapted to the production of good concrete units. It permits the use of a wetter mix, and the use of the extra moisture made possible is essential to rapid curing. The use of the stripping principle to face-down machines was never feasible until the new Abram machine was developed.

The principle involved, and patents upon it have been applied for, consist of a means of stripping the mold box from the cores and plates, in a horizontal movement, and in the same movement giving the confined block a quarter turn and delivering it onto a cableway, which passes it forward into the curing room. The mold box instantly returns to position to receive the material for the next unit, the cores and the plates remaining in fixed relation at all times, and the face plate remaining in fixed relation to the movable grid plate.

The mechanism performing the sequence of timing operations is most simple. The main gears rotate at the rate of 3 r.p.m. and run in an oil bath. They are enclosed in the main base, which weighs about one ton.



This is the new automatic down-face stripper recently announced by the Abram Cement Tool Company

The block are made by a succession of alternately delivered blows from tamping bars of sufficient weight to insure a maximum density in a minimum time. While the entire machine weighs about three tons and is built for heavy duty, only 2 h.p. is required for operation. The machine is quiet in operation and does not vibrate the supporting floor.

At 3 r.p.m. the automatic machine has a capacity of 180 block per hour, but it can easily be speeded up to a production of 240 block per hour, either plain, face, or fractional block.

The same concern has developed a power tamper that is very simple and appears to be reliable. An interesting feature is the safety latch and safety collar that makes it impossible for any tamper bar to fall out of time, or to fall at all except at the will of the operator.

These machines, together with a well-known line of cement-finishing tools, are made by the Abram Cement Tool Company, 3818-3834 Grand River Avenue, Detroit, Mich.

Two New Clamshells Announced by Hayward

The Hayward Company has designed two new Clam Shell Buckets especially for use in connection with cranes of the Crawler Type and Truck Mounted Cranes and Derricks. One is of the Class "E" or power wheel type and is of rugged though light construction. It is to be used for handling sand, gravel, broken stone and coal. This bucket is very quick acting and can be operated at a very high speed—faster than any sheave operated bucket, say the manufacturers.

One feature of great advantage claimed for these smaller machines is the limited head room required for operating this bucket—less than other $\frac{1}{2}$ cu. yd. Clam Shell Buckets—allowing greater clearance over cars, higher stock piles and, consequently, greater operating efficiency for the machine on which this bucket is used.

The other is of Class "G" or rope-reeve type and is to be used particularly for natural excavation, such as digging sewer trenches and other stiff digging. Both buckets are of $\frac{1}{2}$ cu. yd. capacity.

These buckets were on display at the Hayward Company booth at the Road Show.

The advent of the new, improved "Berg" concrete surfer and finisher is announced in circular form by the Concrete Surfacing Machinery Co., Cincinnati, Ohio.

The Berg's job is the removal of fins, board or form, marks, cutting through to expose the aggregate to receive float or other finish, and for finishing on bridges, stadiums, power plants, etc., at an average rate of 60 sq. ft. an hour.

The Berg is self-adaptable to any surface, and in a few minutes can be changed from horizontal wall to overhead operation. The head is equipped with, respectively, the tool head, flexible disc, carbo plate, cutter plate, and 24 cutters, weighing 14 lbs., the total weight, including motor, being only 35 lbs.

The surfacing and finishing of Bear River bridge, 330 feet over all and the largest concrete bridge in Utah, as well as numerous other jobs on bridges, monuments, and interior and exteriors of buildings, has been accomplished with the Berg.

Mixer Musings

Reported by "Joe"—The Mixer Boss.

Skinner, the Boss of the Hurry-Up Co., Checks Up

The president of the Hurry-Up Construction Co., home builders, and his partner were takin' stock a month ago, from what Bill, their boss mudslinger, tells me, and they woke up to the fact that Uncle Sam wouldn't have such a drag with their bank roll this year as they first had expected, even though they didn't shave their tax report quite so much as last year.

In spite of the fact that their jobs was starved on cement and left sittin' high and dry on no more footin's than a hunk of mud an' good wishes, and in spite of the fact that they had made block in a back-yard plant at a cost lower than any block could be made for, and used them on their work, and in spite of the fact that their stucco was dabbed on one-coat work, and other parts of the work were skinned in a like manner, yet their balance sheet failed to show the expected profits.

Then they came to remember how one buyer after another had come back to have crackin' plaster patched up, and to have new shorin' put in by the carpenter, and how the concrete wall of one house had to be painted with a waterproofin' to stop a pernicious sweatin' that was caused by lack of waterproofing a badly skinned mix, and how six buyers renigged on their payments on account of dissatisfaction and the houses had to be repaired and placed on the market at a reduced price, and how another party had ordered a lot of early repairs and sent the bill to the builder, and how the drains in another house got clogged with shavin's left by the carpenters and the basement floor had to be torn up and replaced, and they soon saw that a lot of little items had eaten up what would have otherwise been clear profit.

And on top of all this the bookkeeper showed 'em how lots of bills had to ride and lose the discount, and how they had to pay high prices for materials because of shoe-string financing, and how the paper had to be discounted on hard terms for the same reason, and how the labor costs ran high because of lack of high-priced supervision on the jobs, and they then saw that shoddy speculative buildin' was costing them more than if they had put on a good superintendent, ordered better materials, and had the working capital of a real business.

When they talked about changin' the scheme of things, Bill told me they found from a couple of agents that their houses were getting harder and harder to sell, and that it would be a long fight to overcome the bad name that their old methods had gained. He said these builders just bought tickets to Florida, where they had a chance to get a new start and learn how to profit more from building better homes. They learned their lesson, as many have done before them, but their shoddy work still remains—a blot on the community.

I tell you, th' greatest sucker isn't the buyer of the shoddy home, but the builder of the same.

Don't holler when the state tells you to follow specifications. People have a funny habit of getting sore when they have to keep paying for a road after it has to be replaced. Good construction is cheaper in the long run than a skinned job,—even for the contractor.

Many a mixer has given longer life because of a daily bath, and many a repair bill saved. A little water is good for the equipment, but too much can play hob with the concrete.

There's many a slip between the bid and the bank account. A good system of cost keeping is like ashes on a slippery sidewalk. Keeps you on your toes and saves many a bad spill, while the other fellow brings home the bacon.

Let's swop ideas, anyhow. *Joe, the Mixer Boss.*

News of the Industry

With the Manufacturers

Mr. P. A. Koehring, general manager and secretary-treasurer of the Koehring Company, Milwaukee, was recently elected president of the Milwaukee Association of Commerce.

The American Hoist and Derrick Co., which has works and main offices at Saint Paul, Minn., has recently opened another branch office at 1943 Railway Exchange Building, St. Louis, Mo., with Mr. Ward B. Maurer in charge. Mr. Maurer has a wide acquaintanceship among railroad men and other users of hoisting machinery. Some years ago he was a member of the engineering staff of the Baltimore and Ohio Railroad.

The Heltzel Steel Form & Iron Co., Warren, Ohio, has appointed Chadwick Bros. Co., corner 25th and Clybourn Sts., Milwaukee, Wis., as its representative on steel sidewalk forms, curb and gutter forms, curb forms, etc., in the state of Wisconsin.

C. S. Wert, of Kendallville, Ind., has purchased the entire plant and business known as the Wert Manufacturing Company, of Chicago and of Kendallville, Ind. Mr. Wert will continue to manufacture a full line of concrete machinery, consisting of block machines, brick machines, power tampers, well molds, cistern molds, and silo molds, as well as the Wert ornamental, face and tapestry brick machine. Mr. Wert's office is at 602 N. Main St., Kendallville, Ind.

The Celite Products Company announces the removal of its San Francisco office from the Monadnock Building to 140 Spear St., San Francisco. This change is made to provide larger quarters and better operating facilities.

The Huron Portland Cement Company, 1325 Ford Building, Detroit, has been appointed exclusive sales agents for Ford Portland Cement, manufactured by the Ford Motor Company. All matters relating to the sale and distribution of Ford Portland Cement will be handled by the Huron Portland Cement Company.

Trade Associations

Mr. V. H. Ahearn has been promoted to fill the vacancy caused by the death of Mr. T. R. Barrows, executive secretary of the National Sand and Gravel Association and editor of the *National Sand and Gravel Bulletin*. Mr. Ahearn has been with the association, in another capacity, since 1921 and is well acquainted with the policies formulated by the late Mr. Barrows. As secretary, Mr. Ahearn will carry out the same policies that have resulted in constructive work along the lines of advancing the industry. With both Mr. Ahearn and Mr. Stanton Walker in the Washington office the association membership can be assured competent and personal service on any matters submitted.

The Portland Cement Association announces the opening of an office at 939 O St., Lincoln, Neb., under the direction of Donald D. Price, district engineer. This office has charge of the Association work in the state of Nebraska. Mr. Price has been connected with the Portland Cement Association for the past year and a half as field engineer in Nebraska. Since his graduation from the Civil Engineering Department of the University of Nebraska, he has filled a number of important engineering positions in the state, as well as having engaged in consulting engineering practice.

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New Books

"The Bureau of Standards," Service Monograph No. 35 of the United States Government, by Gustavus A. Weber. Published by the Institute for Government Research. The Johns Hopkins Press, Baltimore, Md.; 299 pages; cloth bound.

Like all other service monographs prepared under the auspices of the Institute for Government Research, this volume is an exhaustive treatise on the history, organization and activities of the Bureau. It tells of the investigations in the many fields covered by the governmental research organization and cites the progress made in each of the major investigations to date. Financial statements and appropriations are presented for the information of the reader. It is a complete study of every phase of the work of the Bureau, and presents for the first time the information that is needed in order to further the work of co-ordination and reorganization of this department together with other governmental agencies according to the plan that is maturing in Washington. The complete series of monographs, when completed, will afford a scientific mass of data upon which such organization can be based.

Trade Publications

"Novo Power," the house organ of the Novo Engine Company, Lansing, Mich., in a recent issue contains an elaborate, two-page broadside, depicting the various products. In the latter are found, following an editorial or two on road topics, a page devoted to the company's officials, and interesting information on the new 2-cylinder Novo engine, which is equipped with an independent drive shaft and is capable of developing 3 to 6 h.p. Details on this, as well as on rock crusher power, are furnished.

"Six Steps in Building or Buying a Home" is the title of a pamphlet that was recently published by the American Construction Council. This is a folder directed at prospective homeowners, and is intended as a guide to a buying policy that would create a desire and a demand for a sounder housing investment. Its mission is to tell the prospective owner how to take the right steps toward the building or the purchase of a home, referring him to the reliable real estate firm, the sound financing house and financing methods, the good architect, and the responsible contractor. It tells him the things to ask about and the things to avoid. Written in an easily read form, this should prove to be a good booklet to send to your prospects. Copies may be secured for a nominal amount upon application to the Council, at 28 W. 44th St., New York City.

Eberling Tile, Brick and Block Machines are described in an interesting booklet recently published by the Eberling Machine Sales Company, of 2394 Canal Road, Cleveland, and of the Peoples Gas Building, Chicago. The booklet gives some interesting facts about the size of the concrete products industry, defines the automatic machine, and tells of the development of the new Eberling machine that was designed for quantity production. The Eberling Building Tile, turned out in great numbers by the new machine, is given a complete description. According to the booklet, the new Eberling machine is capable of turning out an enormous quantity of tile or brick, and is designed to outlast the usual products machine. Several pages are given to a description of the Eberling continuous mixer, and the book closes with data that should be considered when planning a products plant. The new machine was designed for the large plant where tile or brick are to be manufactured on a large scale and at the lowest possible unit cost. The capacity is 5,000 four-inch tile per day.

A machine that paints uniform traffic lines at the rate of 200 to 300 lineal feet per minute on concrete, asphalt, granite, brick or wood block is described in an informative little booklet on the Ault Traffic Line Machine, manufactured by the Tennessee Tool Works, Knoxville, Tenn.

Painting or spraying walls, bridges, fences and traffic, safety and zone lines 3 to 8 inches wide, as well as stenciling signs, all look alike to this light weight and practical marking machine, said to be capable of doing the work of 10 to 15 men using hand brushes.

Ready for operation, the dimensions of the machine are 26x60 in. by 48 in. high, with a tank capacity of eight gallons of any liquid such as paint, whitewash, etc.

"Summary Bulletin Fifth Annual Meeting of the Highway Research Board" has just been issued by that organization from the office of the National Research Council, Washington, D. C. This bulletin contains a foreword on the bulletin itself, a page on the organization and membership of the board, information on its organization, a list of current investigations, a list of State Contact Men, a list of University and College Contact Men, and summaries of reports presented at the fifth annual meeting. These reports were from the committees on the Economic Theory of Highway Improvement, Structural Design of Roads, Character and Use of Road Materials, Highway Traffic Analysis, Highway Finance and Maintenance of Roads.

Organizations

American Concrete Institute; Harvey Whipple, Secretary, 2970 West Grand Blvd., Detroit.

American Concrete Pipe Association; M. W. Loving, Secretary, 111 West Washington St., Chicago.

American Construction Council; Dwight L. Hoopingarner, Executive, 28 W. 44th St., New York City.

American Engineering Standards Committee; Dr. P. G. Agnew, Secretary, 29 West Thirty-ninth St., New York City.

American Road Builders' Association; Wm. H. Connell, President, Miss E. A. Birchland, Secretary, 29 W. 39th St., New York City.

American Society for Testing Materials, C. L. Warwick, Secretary-Treasurer, Engineers' Club Building, 1315 Spruce St., Philadelphia, Pa. Annual meeting, June 21-25, Atlantic City, N. J.

Associated General Contractors of America; D. H. Sawyer, Secretary, 1038 Munsey Bldg., Washington, D. C.

Associated Metal Lath Manufacturers; 123 West Madison St., Chicago; Wharton Clay, Commissioner.

Building Officials Conference; Frank Burton, President, J. F. Downey, City Hall, Cambridge, Mass., Secretary.

Concrete Reinforcing Steel Institute; M. A. Beeman, Secretary, 160 North La Salle St., Chicago. Annual meeting, March, 1926, Atlantic City, N. J.

Concrete Products Association; John E. Powers, President, Sterling, Ill.; D. R. Collins, Secretary, Milwaukee, Wis.

Mid-West Concrete Products Association; D. R. Donlen, Secretary-Treasurer, 4340 Marcy St., Omaha, Neb.

Ohio Concrete Products Association; G. M. Friel, Secretary-Treasurer, 2284 North High St., Columbus, Ohio.

National Association of Building Trades Employers; A. E. Coleman, President, 37th St. & Stewart Ave., Chicago. A. W. Dickson, Executive Secretary, 214 Electric Bldg., Cleveland, Ohio.

National Association of Builders' Exchanges; William F. Chew, Baltimore, President; Earl F. Stokes, Secretary, 15 East Fayette St., Baltimore, Md.

National Crushed Stone Association; J. R. Boyd, Secretary, 751 Earle Building, Washington, D. C.

National Housing Association; Lawrence Veiller, Secretary and Director, 105 East Twenty-second St., New York City.

National Sand and Gravel Association, V. P. Ahearn, Executive Secretary, 903 Munsey Bldg., Washington, D. C.

The National Lime Association; Burton A. Ford, Secretary, 918 G. Street, N. W., Washington, D. C.

Portland Cement Association; William M. Kinney, General Manager, 111 West Washington St., Chicago.

Wisconsin Concrete Products Association; A. P. Kuranz, Secretary-Treasurer, 425 E. Water St., Milwaukee.